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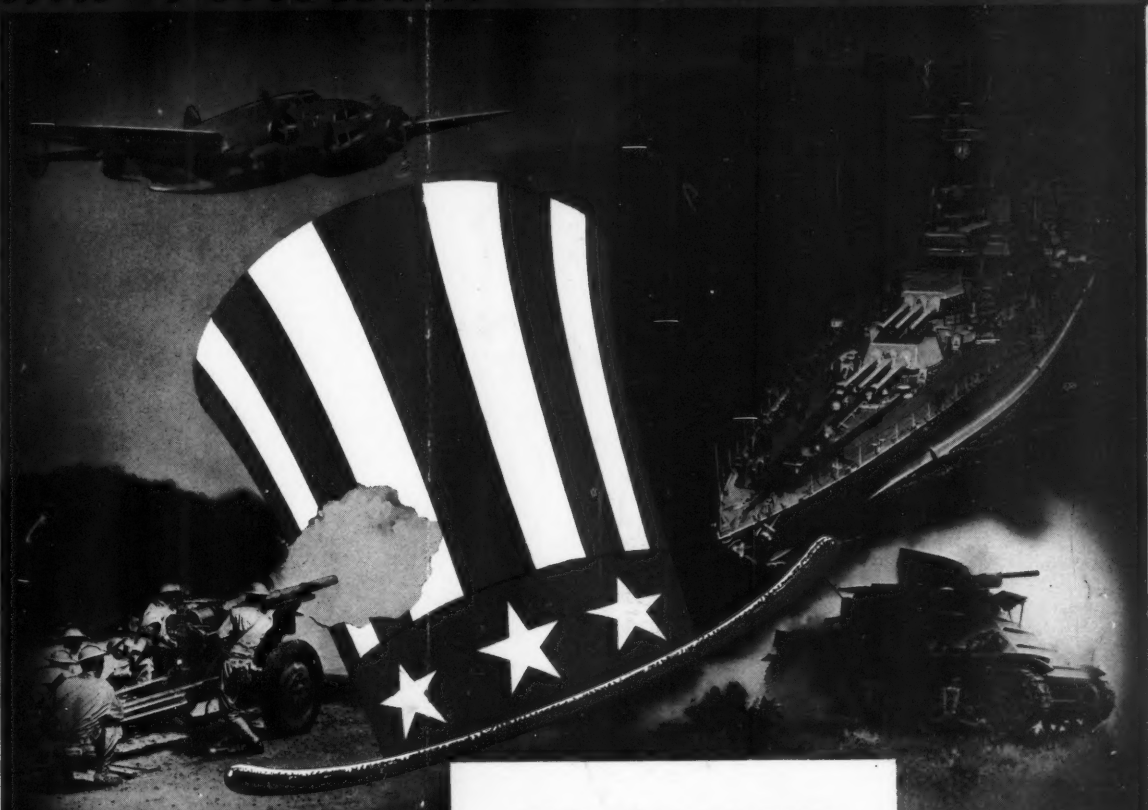

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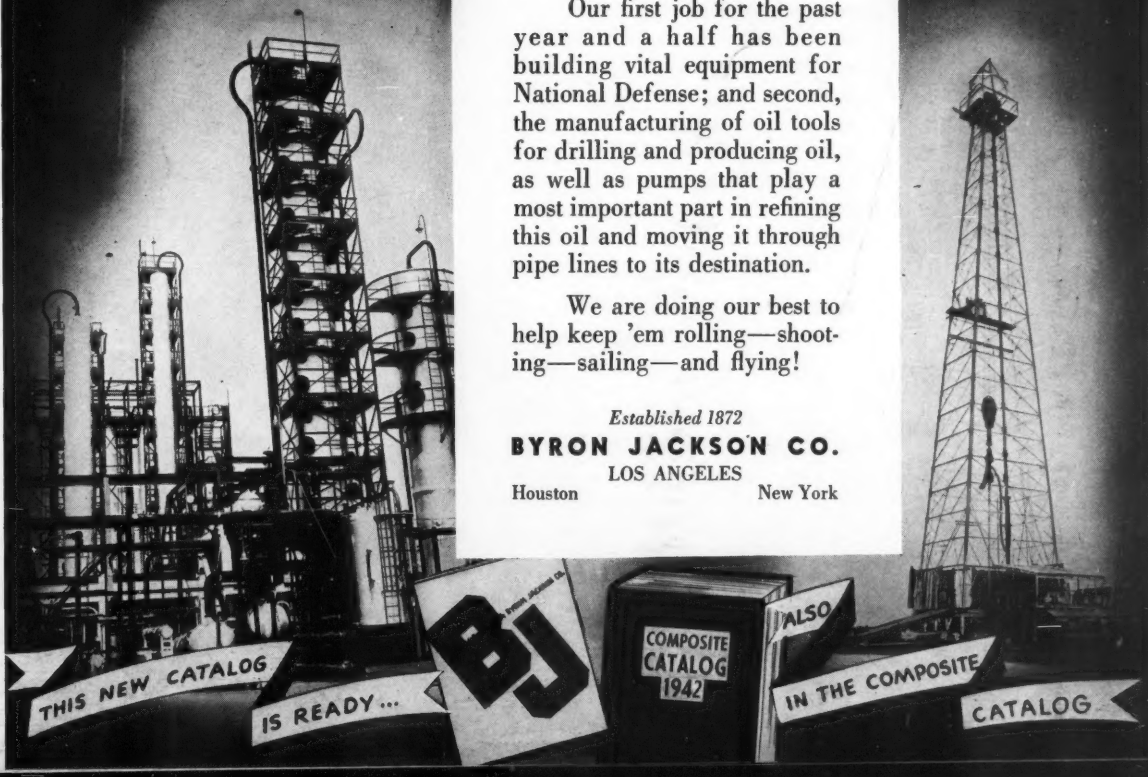

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No. 2
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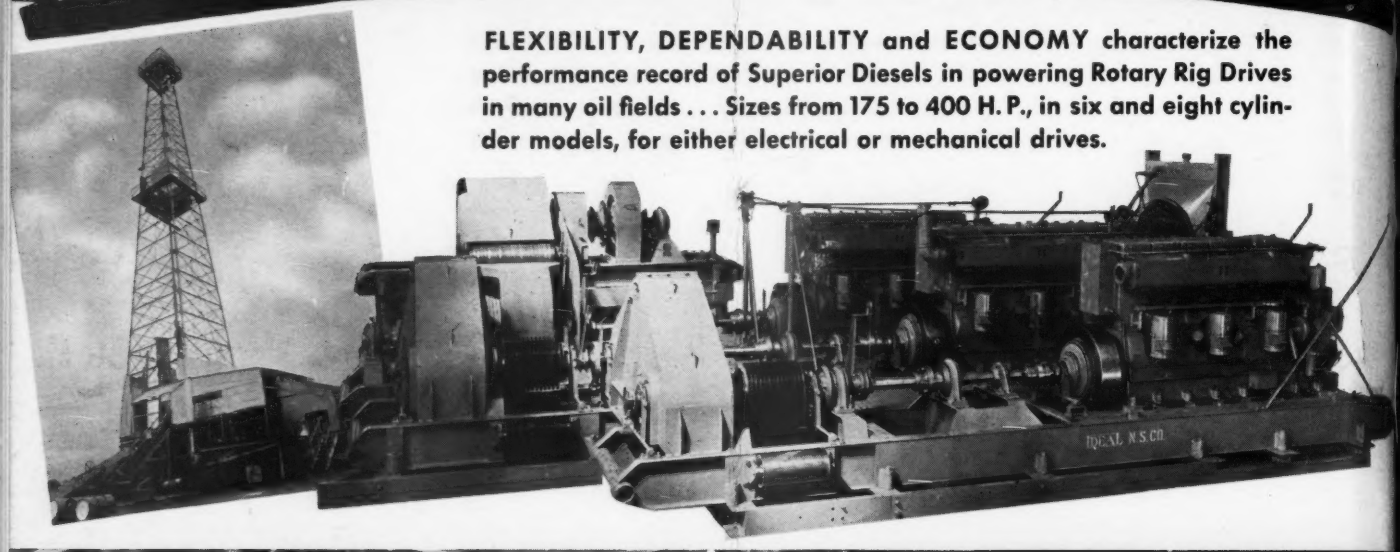

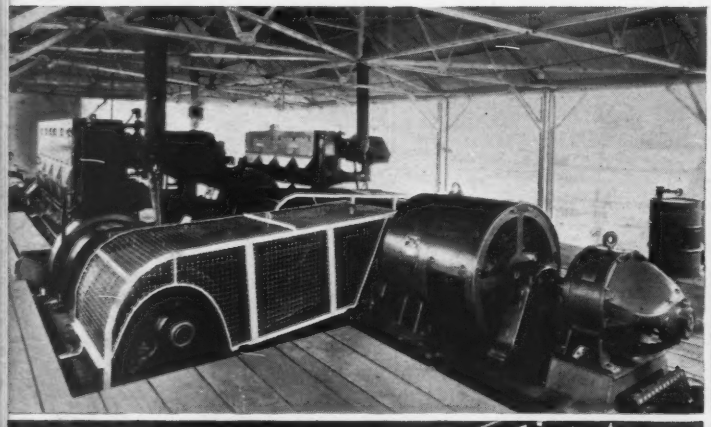

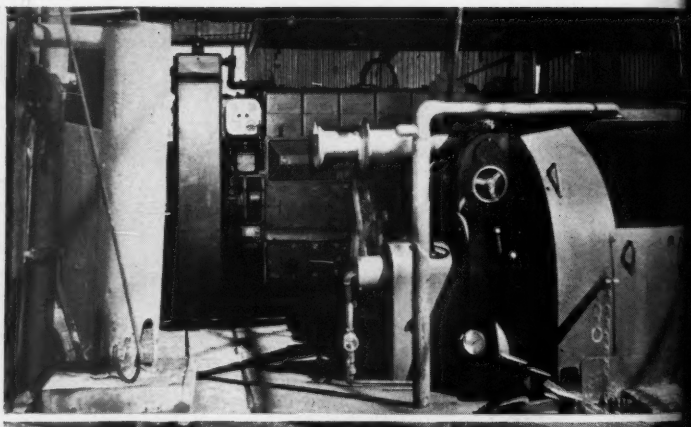

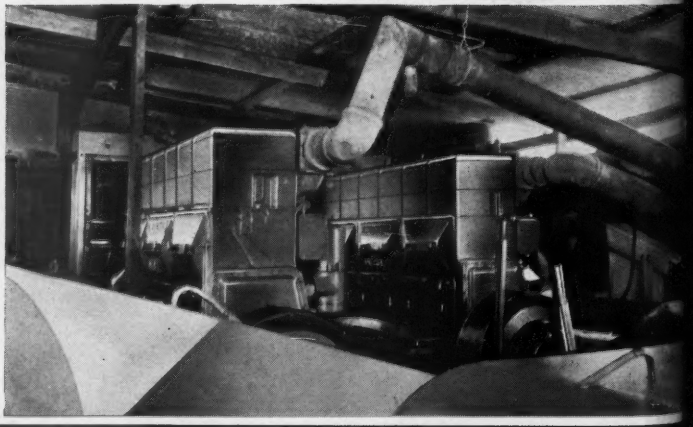

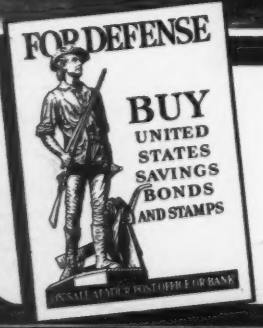

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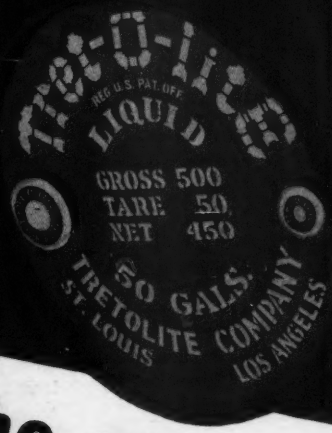

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Factors Affecting Reservoir Performance

A Timely Review

R. D. Wyckoff*

In the early days of the petroleum industry, and continuing until little more than a decade ago, the engineer was concerned primarily with those problems accompanying the drilling and producing of wells and associated equipment. This limitation in scope was due not to any failure to recognize other phases of the production problem, but to conditions in the industry. The demand called for high rates of production from then known sources of supply. Inasmuch as the wells are the important mechanical units through which oil must be withdrawn, the wells and their associated equipment were the bottlenecks on the reservoir, and hence they—not the reservoir—were the targets for technical effort.

The emphasis on rapid development and production, coupled finally with adequate reserve discoveries, led inevitably to a great surplus of wells and a potential output far in excess of current demands. Such a situation resulted, as always, in economic pressure, which forced a change in viewpoint; and thus emphasis naturally shifted from the function of wells to control of production, thence to conservation, and finally focused on the reservoir and its performance.

This resume is presented not for its historical color, but to indicate why, in an industry as old as this, and almost 10 years after the urgent need arose, many engineers are still in disagreement regarding fundamentals. For only with the advent of an era of slower returns did the industry sudden awaken to the importance of technical studies outside the realm of drilling and production technique, and practical operators to take a more serious interest in what heretofore had been looked upon more or less as academic pastimes. During the past 10 years laboratory research has not been unduly lax, but the necessary coordination of such work with actual operating technique requires time and has not been adequate to provide the maximum rate of advance. Neither laboratory study nor research in the field is alone sufficient to provide solutions to the problems which now are pressing. Experience indicates that in the future the industry must provide better coordination between so-called theoretical and practical production research.

In attempting at this time to outline concisely the factors affecting reservoir performance, and particularly to describe technique capable of determining those factors, we are handicapped by the relatively immature state of development in reservoir technology. Important basic theoretical facts are known, and idealized analyses are possible. What is needed are the qualifying factors obtainable only from experience, which will permit the application of theory to practice or, rather, which will provide assurance to all concerned that reservoir performance is determined by, and does follow, definite physical laws, the fundamentals and many details of which already are known.

We are well aware that the technologist's apparently insatiable appetite for more and more detailed information from the field is almost equalled by the operator's horror at its cost and time consumption. It has been said facetiously, but with some justification, that to run into a well all of the data-procuring "gadgets" now available would leave neither time nor funds for drilling and producing. However, as production engineers have been willing gradually to shoulder some of the technologic stigma, some of these data have been secured and their value proved. At present almost every conceivable measurement is specified as necessary or desirable and, because of the dearth of experience, it is impossible at this time properly to cull the items and prescribe only that which is pertinent. This condition will remain until sufficient experience has accumulated to permit specification of the relevant minimum.

It is hoped that this rather lengthy introduction may serve to emphasize that in the discussion which follows we are not attempting to write specifications, but merely to indicate the general type of field data needed and the possible scope of application.

I. Classification of Factors Affecting Reservoir Performance

It is not exaggeration to say that every detail regarding a petroleum reservoir and its fluid content, as well as the manner in which it is handled, is a factor affecting the performance of the reservoir. Moreover, these factors are so interrelated that it is impossible to consider them one by one and evaluate properly their influence upon the overall behavior of the reservoir. Under a given set of circumstances certain factors predominate and practically control the performance, whereas under other conditions those factors may play only a minor role. It is the complex interdependence which makes it impossible in general to discuss details of reservoir performance, without first stating explicitly the exact circumstances under which the various factor are involved. It is the failure to consider the whole picture, or the inability to present it in its entirety due to the lack of essential information, that leads to misinterpretation or disagreement regarding the behavior of a reservoir or its producing wells. Certainly the fundamental physical facts are now sufficiently known adequately to

Stripper wells will produce more than half of California's crude oil quota in February, if present plans of the Conservation sub-committee and the Production committee for District 5 are effective. The allocations group, headed by William Whaley, urges prompt reports on the status of shut-in wells, pointing out that quotas cannot be given to such wells not entered in the records before the 15th day of the preceding month.

While the production and refining set-up for California is still far from clear, a telegram from Petroleum Coordinator Harold L. Ickes to E. E. Pyles, production chairman for District 5, stressed four points for immediate guidance of Pacific Coast petroleum activity: (1) production of heavy oils must be increased; (2) first consideration must be given to stripper wells; (3) in allocations of production the problem of transportation must be given first consideration, and, (4) there is no immediate probability of a request for high octane California base stocks.

It was pointed out in the First Issue, January, 1942, of the California Oil World that considerable stress would be given to the production of fuel oils in California, however, it is not possible to lose sight of the fact that many California crude oils provide the best materials for the production of high octane gasolines. Not to be caught napping, the Production Committee for District 5 has technologists at work compiling all necessary information as to sources of superior anti-knock crude stocks.

Shell Oil Co., Inc., Standard Oil Co. of California, Superior Oil Co., Tide Water Associated Oil Co., and Continental Oil Co., have contributed the services of their petroleum engineers, without expense to the committee, to the Production Committee for District 5, to ascertain optimum production rates for oil pools in California. Dick French, of Continental, is chairman of this board of engineers.

Requiring legal counsel, the Production Committee for District 5 was tendered the services of Martin Weil, by General Petroleum Corp., without expense to the committee. Mr. Weil was made secretary of the committee, succeeding L. L. Aubert, whose other duties in committee work have increased tremendously.

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cover the essentials of most production problems, if the knowledge of field conditions were defined sufficiently to permit analysis. Our most urgent need at present is more definite knowledge concerning conditions within any reservoir, so that the primary factors may be isolated and the performance analyzed. In the situation usually presented we are reminded of Buckles's statement in his History of Civilization in England: "We live in that predicament that our facts have outstripped our knowledge and now encumber its march."

It is difficult, in view of this interdependence, properly to classify the various factors in an attempt to segregate them in the order of their importance, and thus simplify discussion. The only segregation that seems justified is the very broad division:

1. Factors inherent in the reservoir, and over which little or no control is possible.
2. Factors influenced by the exploitation program, i. e., under partial or complete control.

Thus, merely for convenience, we shall consider first the more or less fixed reservoir characteristics, and later those factors influenced by operating technique —bearing in mind that the latter should be determined by the former, and hence in practice the picture must be viewed in its entirety.

II. Reservoir Factors Affecting Production Performance

Type of Reservoir

Any reservoir presents certain characteristics with which it was endowed originally, and over which we have very little or no control. Each of these has some influence over the reservoir performance, and indeed some of these may so far overshadow all others as to dictate the technique of production. The type of reservoir is, therefore, a matter for first consideration; and by "type" is meant details concerning:

1. Structural characteristics
2. Pay-zone characteristics
3. Fluid content

1. Structural Characteristics

In general, reservoirs may be any one or a combination of domal, faulted, lenticular, or stratigraphic traps. Insofar as the dynamic performance of such reservoirs is concerned, the particular type merely determines whether regional flow is symmetrical as in a uniformly developed domal or lenticular type, or onesided as in many stratigraphic or faulted traps. However, the importance of such information in the planning of an efficient development program is too obvious to require elaboration.

Even more important than the structural type is the amount of closure involved or, in other words, the steepness of the dip within the reservoir. For, as will be discussed later, the efficiency of production directly is related to this structural factor, provided other conditions permit its use advantageously.

2. Pay-Zone Characteristics

The pay-zone characteristics are evidently a primary factor. In general, pay horizons are either sand or limestone and, as far as production performance is concerned, any formation having porosity of the type found in sands will have similar performance characteristics. Thus, as regards the production mechanism, certain types of porous limestones may be classed with sands. Likewise, highly fractured limestones may, on a large scale, simulate certain characteristics of sand reservoirs. However, in general, fractured or cavernous pay zones require special consideration, depending on the size and lateral continuity of such fractures or cavernous features. Evidently the performance of such a reservoir will be characterized by very high erratically distributed well potentials, rapid equalization of pressures, and, in general, will perform as a unit with very low internal resistance to flow. Principles regarding the internal mechanism characteristic of sand pays[1a] will not apply, and it is particularly advantageous that operating technique be designed to take full advantage of structural configuration whereby gas cap or natural water drive may be utilized efficiently, for these highly permeable reservoirs are inherently amenable to such operation.

Multiple pay horizons: It is evident that if several pay horizons exist with sufficient vertical separation, they should be considered as separate reservoirs. Multiple pay horizons, as here considered, refer to a reservoir in which wide variations in sand characteristics occur within a single pay zone. Inasmuch as each portion of pay, defined by certain porosity and permeability values, will behave in production in accordance with these individual properties, uniformity of the pay zone is an important factor in reservoir performance, requiring special consideration.

Moreover, inasmuch as these variations as observed in individual wells may represent either sand lenses in a relatively impermeable shale matrix or shale lenses in a sand matrix, it is important to determine which case characterizes the reservoir. or evidently, if the pay comprises sand lenses, for maximum recovery the well density used must be such as to provide penetration of individual lenses . On the other hand, shale lenses in a sand matrix will not break up seriously the continuity of the pay zone, and well density becomes of secondary importance. In fact, if water is involved, such lenses may be advantageous in providing impermeable barriers at which plug-back operations may be aimed and water coning in individual wells effectively controlled.

3. Fluid Content of the Reservoir

The intelligent handling of any reservoir presupposes a detailed knowledge of the fluids contained therein. This involves not only information regarding the type of gas and oil, but the degree of gas saturation in the oil, and data regarding the release of gas from the oil as pressure is reduced. If the oil is saturated with gas, a free gas cap probably is present, and in this case the size of the gas cap and the boundaries of the gas-oil contact should be known. Similarly, if bottom or edge water is present, a knowledge of the oil-water boundary and its mobility (rate of encroachment when reservoir pressure declines) is as important as information regarding the gas cap, because the ultimate recovery efficiency may depend upon proper utilization of the natural water drive.

In recent years a new type of reservoir has become of major importance. This is the so-called single-phase or gas-distillate type. Proper handling of such reservoirs definitely requires knowledge of the volumetric and phase behavior of the reservoir gas, and is obtainable only by careful sampling and laboratory analysis.

III. The Determination of Reservoir Factors Affecting Production Performance

The foregoing outline indicates that every available scrap of information regarding the reservoir is of value to the engineer in analyzing reservoir performance and planning reservoir exploitation. It is evident also that the obstacles in the way of realizing such complete knowledge in actual practice are numerous, and some are as yet insurmountable. However, some of these data are obtained by special devices; others by careful analysis of the performance of the reservoir under actual operation.

Core Analysis

Although the structural information available during the initial stages of development may be meager, exploratory development at an early stage could provide the essential facts. Pay-zone characteristics may be obtained from the first few wells, provided they are adequately (continuously) cored through the pay zone, and complete core analyses are made in a reasonable number of key wells. Special logging devices (i. e., electrical) run in all wells, through correlation, will serve to extend the actual physical analyses from key wells to adjacent areas.

Thus, careful coring and complete core analysis appear to be essential for any intelligent development. Moreover, it

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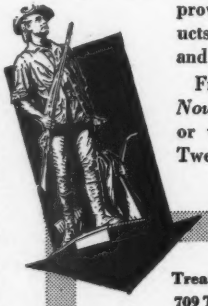

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seems to hold the only hope whereby pay-zone characteristics can be determined. And, incidentally, experience seems to indicate that it is a profitable procedure, even if used only as a guide in completing wells, not to mention the value of the data at later dates in planning development and operating procedure.

Without going into the question here, the determination of reserves is at once one of the most important and evasive problems confronting the industry—important not only in economic considerations, but in the direct evaluation of the influence of various factors here discussed on the performance of a reservoir. And on cursory consideration it might seem that the process of direct sampling of the reservoir by coring and subsequent careful analysis in the laboratory provides an immediate solution not only to questions regarding porosity, permeability, and other physical properties of the pay, but to questions regarding the fluid content of the pay **in situ.** In regard to the physical properties of the pay, the information is ascertained indeed directly and adequately. In the case of the fluid content of the cores, the data are less certain, for the sample analyzed is not one under reservoir conditions, but one which has been exposed to modification, both by contamination due to filtrating drilling fluid, and subsequent reduction in pressure analogous to a production process carried to depletion. Therefore, in practice the original fluid contents are **inferred** by suitable statistical information, coupled with the knowledge of the **residue fluids** observed in the core sample. Various techniques, not describable here, are used to convert the observed values to those representative when the core was undisturbed in the reservoir. Recently special core barrels[2, 3] have been designed with the view to bring core samples to the surface in pressure-tight chambers, so that the reservoir pressures and fluids are retained. However, neither of these yet offers a solution to the problems of contamination by infiltration of drilling fluid.

We have indicated the difficulties involved in core analysis because of the importance of the method, for it seems to offer the only direct solution to the problem of determining reserves and depletion in small areas. However, it will require very excellent technique to obtain depletion figures with sufficient accuracy to lead to significant conclusions regarding the influence of various factors in reservoir performance, which is now the subject of endless controversy. However, encouraging results have been reported, and improvement with added experience and application is certain, and should be expedited.

Bottom-Hole Sampling and Pressure Measurement

In addition to the determination of the fluid content of the resevoir by core sampling, it is also important to analyze bottom-hole fluid samples obtained under the existing pressure. From such samples may be obtained information concerning the gas content of the oil and its saturation values under declining pressure, which are absolutely essential to a proper understanding reservoir performance. Moreover, in a gas-drive field, a comparison of the reservoir gas-oil ratio with the ratio produced provides a direct measure of current operating efficiency. In passing it might be mentioned also that a careful analysis of gas from an apparently single-phase reservoir, coupled with present-day knowledge of phase equilibria in hydrocarbon mixtures, may serve to indicate saturation conditions pointing to the existence of an oil zone on the flanks of the structure. Needless to say these structures also require bottom-hole pressure measurements which, together with bottom-hole samples, should be a routine procedure in discovery wells; but further consideration of these factors will be given later.

IV. Factors Influenced by the Exploitation Program

Due to the complex interrelation already mentioned, it is impossible to draw a sharp line of demarcation between factors rigidly fixed by reservoir conditions and those under complete or partial control by the operator. An attempt has been made to do so in order to simplify discussion. Having considered briefly what we have called "reservoir factors," a similar outline of "controlled factors" will be undertaken. And here the problem becomes more complex, because the interdependence of all factors pervades the entire picture.

The Function of Wells

Certain general statement regarding the wells themselves may be made without much qualification. The function of wells in a petroleum reservoir has been defined concisely by Moore[1] as "the important mechanical units through which oil (or gas) must be withdrawn, and which provide information necessary for the efficient control of the reservoir." It is a fact that two conditions, and these alone, permit the production of oil wells:[4] 1, the oil must be displaced from the reservoir by some other fluid, either gas or water; and, 2, a pressure gradient must be set up between the portion of the reservoir yielding oil and the well bore from which it is withdrawn. Hence unless a well is introduced gas or water into the reservoir, as in water flooding or repressuring, its function only can be to reduce flow into it. Except insofar as the equipment in the well serves to affect its bottom-hole pressure, this equipment is not a factor in reservoir performance. Moreover, the fluids—gas, oil, and water—produced by the well are determined completely by reservoir conditions and the pressure maintained at the well bore, and are not affected otherwise by the well's equipment. Thus the bottom-hole pressure in a well is the primary factor, not the well, although its equipment is instrumental in the control of pressure.

Location of Wells in the Reservoir

The location of the bore hole in a reservoir is (ostensibly) under the operator's control, and both its location on structure and position vertically within the pay zone are important factors. However, the relation of well location on structure and reservoir performance involves other factors, which will be considered later.

It is evident that in a zone of multiple pay horizons the vertical position of the open bore hole with respect to the individual pays markedly will affect performance. Thus completion below a gas zone minimizes gas production, or plugging back may eliminate bottom water. Such operations may be handled most effectively if complete core analyses are available; and the principles involved, and which apply to the multitude of similar problems, need no mention here.

Diameter of Wells

The diameter of a well bore as a factor in reservoir performance long has been debated. Theory indicates that, for example, increasing the diameter of a 6-in. bore to 12 in. should increase the potential approximately 10 per cent, and we, therefore, conclude that well diameter for all practical purposes is an unimportant factor. And as concerns the well diameter, **per se,** there is no room for argument. On the other hand, field experience maintains that well diameter has a very substantial influence, although data are erratic and inconclusive. The erraticness of the field data and the seeming conflict with theory all may be harmonized by merely looking for the new factor. Thus it will be found that, whereas well diameter actually may have an appreciable effect, it is an indirect one which would disappear—i. e., conform with theory—if all wells could be completed perfectly. However, the influence of the size of the hole upon the efficacy with which the mechanical completion job may be made is evidently the real problem, not the diameter itself. A good completion, i. e., one in which the sand face or screen liner is left clean and free from obstructions, is clearly important, but the effect of a poor completion is that of a choke, and relates to operating pressure and well equipment rather than to the reservoir. Thus we return to the

original statement that well diameter, per se, is a negligible factor.

Discussion of Reservoir Mechanics

Water Drive

That the production of oil from a reservoir requires its replacement in the rock by either gas or water already has been mentioned. Neglecting for the present any injected fluids and considering only natural processes, it is clear that, in the case of displacement by water, this can be accomplished only by the bodily encroachment of water from regions adjacent to the oil reservoir. To the extent that the mobility of the water drive may be adequate and it is intended to use this natural drive, wells should be so located on the structure as to permit the most efficient utilization of this water drive. When the flanks of a structure have relatively steep dips, so that the gravity gradient due to the difference in density between oil and water may be comparable to or exceed the regional dynamic pressure gradients in the reservoir, then a well-defined oil-water contact and ideal conditions are indicated. Wells then should be positioned at strategic upflank locations in sufficient numbers to provide the proper production rate with a smooth regional pressure distribution.

However, this ideal well-defined oil-water contact with uniform encroachment requires unusual conditions. Inasmuch as the density difference between the oil and water is not likely to exceed 0.2, the gravity gradient tending to maintain a uniform contact amounts to about 0.1-lb-per-ft elevation between the two fluids, and on a structural slope of 200 ft per mile the maximum available gravity gradients amounts to only 20 lb per mile. This means that, under the assumed conditions, water might advance upstructure through a highly permeable horizon one mile ahead of the main body before gravitational force could balance the dynamic gradient and suppress the fingering. Obviously the effectiveness of gravitational forces in maintaining a uniform level of encroachment throughout an oil zone having horizons of variable permeability is very minor, unless the regional dynamic pressure gradients imposed on the reservoir are correspondingly small. However, some limestone reservoirs do conform to these conditions, and for all practical purposes behave like a tank in which bottom water replaces oil withdrawn from the top, and wells showing water soon reach the abandonment stage.

Evidently, then, the normal performance of a waterdrive reservoir partakes more of the behavior of a horizontal pay zone with edge water advancing through the various strata at rates determined by their relative permeability, i. e., rates of oil withdrawal through these horizons. Yet this situation does not alter the picture as far as proper well locations are concerned, for there appears to be no particular merit in distributing wells uniformly over the entire areal extent of the flanks of the reservoir, except as economic considerations and expediency may dictate. A more pertinent factor than the well location in such cases is a thorough knowledge of the pay section, so that any well-defined horizons of high permeability might be shut off when excessive water production via these channels reaches the well.

In fact, in considering factors of importance in any water-driven field, it may be worthwhile to consider seriously the modern trends in water-flooding operations, for in principle there is no difference. In such questions concerning flooding patterns and well-spacing problems have been relegated to their proper economic criteria,[5,6] whereas the purely technical reservoir problems now involve mainly careful core analysis, attention to individual horizons within the pay zone, and control of operating pressures. Moreover, it may be timely here to point out that, in view of the nature of water drive in most reservoirs due to only partial effectiveness of gravitational forces, the prevailing mechanism of production will be that outlined by Moore,[1] and the recovery efficiency will be governed by these principles of water-oil or even three-phase fluid flow rather than the piston-like action of a body of water as in the ideal case.

Gas Drive

When the oil produced from a reservoir is replaced by gas, the mechanism commonly is termed a "gas drive." This displacement may be accomplished through expansion of the gas cap incident to the decline in reservoir pressure, as well as by gas which always comes out of solution in the oil zone when the reservoir pressure drops below the saturation value. Although a complete discussion of this is out of place here, as was the case of the water drive, it is necessary to include some details in order properly to define the problem. For, because of expected differences in efficiencies, we must distinguish between two types of gas drive, which for identification purposes will be termed:

1. **Internal gas drive**; or, in secondary recovery, **recycling.**
2. **Gas-cap expansion**; or in secondary recovery, **repressuring.**

1. Internal Gas Drive

An internal gas-driven reservoir in the sense used here may be idealized as a horizontal pay zone of very limited vertical dimensions, so that gas segregation or gas-cap formation is not involved, and the drive derives primarily from the displacement of oil by gas coming out of solution. Production from such a reservoir follows the mechanism which has been delineated by laboratory studies,[1] and is characterized by relatively low recoveries in comparison with water drives. This is due primarily to the very low viscosity of gas compared to oil, and the resultant exceedingly high gas-oil ratios, even at relatively low values of oil displacement.

If these laboratory studies of "mixture" flow have contributed nothing else, they definitely have shown the futility of attempting to obtain really high recovery efficiency by internal gas drive alone. This by no means implies that in many cases in which reservoir conditions—particularly structural conditions—permit of no alternative, this method of natural recovery, perhaps followed or accompanied by recycling, is not proper. But the mere fact that subsequent recycling of gas (i. e., internal gas drives) is economically feasible indicates the relatively low efficiency of the primary recovery phase, and the large volumes of gas involved in effective recycling may be anticipated from the characteristics of multi-phase flow.

2. Gas-Cap Expansion

By gas-cap expansion is meant that type of mechanism in which, in its idealized form (analogous to the ideal water drive), the reservoir behaves like a tank in which expanding or injected gas in the top replaces oil withdrawn from the bottom. However, whereas in the case of water drive a density difference of only 0.2 is available to maintain a distinct water horizon, in the case of gas and oil a density difference of approximately 0.8 is available to permit effective functioning of gravitational force. Thus the tendency for gas and oil to segregate into distinct bodies is some four times greater than in the case of oil and water, and, for a given steepness of structure and regional dynamic gradient, there is that much less tendency for the "gas piston" to degenerate into an internal gas drive. That such operation is actually possible and has been achieved in many cases, especially in reservoirs having pronounced structure or high permeability pay, is evidenced by direct observation of the formation or growth of gas caps.

The relative recovery efficiency of a gas-cap drive has not been determined, and is one of the problems that needs field study. However, it seems reasonable that it might equal that of a water drive, and most certainly does exceed that of an internal gas drive.

What has been said about the gas cap, presumed to occupy the highest structural position in the reservoir, also applies—but obviously to a lesser extent—in flat-lying pays having sufficient thickness to permit segregation. If the point of withdrawal is from the bottom of the

pay with the upper portion sealed off, then, to the extent that downward gas coming into the well is controllable, the more efficient gas-cap mechanism is operating. Here again field data are not now available conclusively to determine the actual recovery efficiency.

Secondary-recovery gas injection: In regard to secondary-recovery methods using gas injection as the impelling fluid it is evident that the aforementioned two types apply. In the one case, when the gas is injected in such manner as to obtain only the effect of "sweeping out" the oil by virtue of increased gas flow through the partly saturated oil zone, the term **recycling** seems appropriate, leaving **repressuring** or **pressure maintenance** to describe the methods in which the primary aim is the displacement process involving the segregation of large bodies of gas in the reservoir. It is recognized, of course, that in practice both effects are produced; but certainly there will be one which dominates. And again it should be mentioned that the laboratory studies already referred to indicate conclusively that the aim should be the utilization of segregated bodies of gas as the dominant drive.

In view of these simple principles governing reservoir mechanics — and they are not new—it seems incredible that there could exist any lack of agreement regarding operating plans or the factors involved. Undoubtedly any apparent lack of agreement arises not from purely technical questions, but is the result of conflicting interests dictated by economic, statutory, and other factors quite outside the technologic realm and frequently prejudicial to an orderly exploitation program, even under non-competitive circumstances. In any practical case it usually is necessary to consider a multiplicity of unalterable circumstances which govern the mode of operation. And therein lies the difficulty in attempting to outline physical factors which alone determine reservoir performance. In other words, although the normal influence of such factors follows definite physical laws, the extent to which they may be permitted to operate governs their actual effect.

With this qualification and the brief outline of reservoir mechanisms already given, the physical factors involved may be discussed.

Factors Involved in Water, Gas, or Combination Drive

It is of primary importance, both in planning or currently controlling the operation of a reservoir, to know the energy source responsible for its operation. In regard to the two types of available drives, a fundamental difference affecting their performance characteristics may be mentioned:

1. In a natural gas drive the only available energy is that stored in the beginning, and is represented by the pressure at which the total gas content of the reservoir existed originally. The dissipation of this energy follows well-known laws; and, inasmuch as no new energy is added, it follows that:

> The pressure-vs.-production characteristic will be consistent throughout the life of the field; i. e., the total pressure decline at any time directly is related to the accumulated production (gas and oil), as is also the rate of decline vs. production rate.

2. In a water drive new energy is being supplied continously at a rate determined by the characteristics of the adjacent water reservoir and the pressure gradients induced in it. In fact, the performance of the oil reservoir reflects the characteristics of the water reservoir, and primarily is determined by the latter—except insofar as the operating pressures are concerned. The result is that:

> In a water-driven field the reservoir pressure is not related directly to cumulative production, but involves production **rates;** and, in case of an "elastic" drive, their past history. In general, therefore, a water-driven reservoir is characterized by a direct relation between pressure drop and **production rate,** not cumulative production.

The use of these fundamental characteristics in the determination of the type of drive on which to predicate proper handling may be clarified by a brief discussion. At the same time certain difficult problems in this connection will be emphasized.

Gas Drive

In any type of gas drive the reservoir pressure must exhibit a declining characteristic, for only then can any energy be extracted from either free or dissolved gas. It is evident also that in a purely gas mechanism there can be no recovery of reservoir pressure due to shutdown or curtailment of the output. Thus the combination of these two criteria provides ample evidence of the reservoir mechanism, and failure of a reservoir to gain in pressure during a shutdown is conclusive evidence of inappreciable water encroachment.

Here, however, it is pertinent to emphasize that pressure data must be analyzed completely and carefully; for otherwise, as an example, purely local equalizations of pressure may be interpreted as a rise in average reservoir pressure, and false conclusions derived.

Water Drive

In a complete water drive the fluids withdrawn are replaced by an equal volume of water encroaching the reservoir. Also, it has been mentioned that the performance of the oil reservoir reflects primarily that of the water reservoir. If the latter can be considered as a simple steady-state artesian drive, such that the flow into the oil zone is directly proportional to the pressure difference between the oil and water zones, then the pressure in the oil reservoir at any time will be proportional to the production rate, maintaining a constant value as long as the withdrawal rate is constant. And it be clear that pressure-vs.-production-rate data provide adequate evidence of this mechanism.

However, that this simplicity does always not characterize the performance of a water reservoir was amply demonstrated by a rather unique combination of circumstances, which permitted a clear-cut analysis of the mechanism of the extensive Woodbine water reservoir adjacent to the East Texas Field. Here a complete water drive is associated with a slow, but continuously declining, pressure characteristic. Diagnosis of the true performance of this field involved several factors, and of prime importance was the known undersaturation of the oil learned from careful analysis of the reservoir fluid. Knowing that no gas could come out of solution at the then-existing reservoir pressures, the presence of a complete water drive was a necessary conclusion. And from the production-vs.-decline characteristics, as well as the reaction to shutdown of the field, the now well-known elastic-fluid theory of the Woodbine water zone was derived.

This case has been reviewed in some detail as illustrative of the fact that pressure-decline data alone may not be diagnostic. It clearly indicates the ambiguity which may arise in attempting to distinguish between a water-driven reservoir and one which is a combination water and gas drive. In fact, in the absence of other essential criteria, the elastic behavior of the water drive of the Woodbine type—which actually simulates a gas drive—might be mistaken for the latter alone, and the extent of the oil and gas reserves in the reservoir grossly overestimated. Thus is illustrated the necessity of having not only pressure-decline data and especially accurate information regarding the reservoir's reaction to changes in production rate or shutdown, but also accurate knowledge of the gas-saturation characteristics of the reservoir. This is especially true when a combination gas-and-water drive exists and it is desired to ascertain the relative importance of the two types; for at best this is a very difficult problem, the solution of which may remain ambiguous because of the absence of a single clue.

Some may question the importance of such determinations regarding the reservoir mechanism. It hardly seems neces-

sary, however, to point out that upon such knowledge the entire exploitation and operation programs depends. Insofar as extraneous factors permit of any intelligent planning, then **it is the obvious aim to develop and operate a field that a maximum recovery at a minimum cost is obtained,** and there shall be no secondary-recovery phase involving new expenditures that might have been eliminated had the proper perspective been possible at an earlier stage. Thus if it is possible early in the development to realize that a complete natural water drive is available, an attempt properly might be made to make full use of it, both in the location of producing wells and in their operations. Likewise, a knowledge of the type of gas drive or combination gas-and-water drive will determine in practically every detail the engineering problems incident to development and production. Moreover, even though circumstances do not permit development based upon consideration of the reservoir as a whole, there remain many of those incidental problems—individual well or lease problems if you like—the solution of which depends upon a thorough knowledge of the reservoir mechanism.

Wells as Factors in Reservoir Performance

The function of wells and some details regarding their completion have been mentioned earlier. In regard to the influence of the areal distribution of wells in a reservoir, Moore[1] ably has stated: "In every field there is a zone into which oil naturally migrates under the force of an efficient gas or water drive, and it is within this zone that wells assume their greatest importance. In locating and completing the wells, the most important consideration should be the control of the displacement of the oil by gas or water. The number of wells is of minor importance, except insofar as a sufficient number must be drilled to provide for adequate control."

This summary of principles requires no further elaboration, for their application is but a matter of detail involving the specific conditions present in individual reservoirs. Their aim is not only conservation of the driving energy but, if possible, to produce from the oil zone without displacing it bodily within the reservoir from its normal environment into new areas where intermixture, particularly in a dry-gas zone, will result in irrecoverable absorption.

However, the statement that "the number of wells is of minor importance . . . except that they provide for adequate control" is deserving of further consideration, as it is one of the most controversial questions in the industry. And I will not hesitate to say here that opponents of the above thesis contend that it is based upon wishful thinking—an expedient theory—rather than one based on facts.

Well Spacing

If well density is an important factor in reservoir performance beyond its influence in providing adequate control, it must involve an effect upon ultimate recovery. This predicates a physical limit to the radius of drainage around a well. And yet, **10 years of intensive search for some physical phenomena in the production mechanism leading to a limited radius of drainage has failed to disclose its existence.** And this refers not to water or gas-cap drives, but to the type which conceivably might exhibit such a characteristic, viz., an internal gas drive. This is laboratory experience, yet it is substantiated by direct observations in the field, where regional migration over very large areas within a reservoir is an established fact, derived from careful study of reservoir-pressure data available in recent years. It is on such data that the concept of an "unlimited" drainage radius of a well is based. However, the term "unlimited" requires qualification; for even the most academically-minded "theorist" has no intention that it be carried to impractical extremes, as a literal interpretation would imply. Even he has stated that "within reasonable limits the spacing of wells is an immaterial factor in the recovery of oil." We shall be specific here and define what is meant by "reasonable," in an attempt to bring the contending schools of thought onto common ground for discussion. If this can be done, it is likely that the argument at least will be more fruitful, and even may result in some semblance of agreement.

Considering only the pertinent type of mechanism, the internal gas drive, first it is important to distinguish between purely physical phenomena and practicable attainments. The controversial theory is based on the necessary assumption that a well be operated until the last dribble of oil has been taken from it, i.e., it presupposes that the reservoir pressure everywhere has attained an irreducible minimum. This is, of course, a practical impossibility; for long before that stage could be reached, abandonment would have been forced by cost considerations. Thus economic considerations set a time limit on the operation of a well, thereby determining the pressure distribution, and hence the depletion of the reservoir in the area around a well at the time of abandonment. For this reason we must consider not purely physical limits of depletion, but economically determined depletion. Thus indeed we may assume that, in this sense (a non-uniform distribution of depletion) a limited radius of drainage does exist, but it is one determined by economic considerations alone.

Let us then consider the well-spacing problem as a purely economic one, and for the moment forget the controversial physical aspects on the basis of which the problem seems to evaporate. From economic considerations it is possible to set a minimum production rate below which it is impractical to operate a well. Then, together with other data—including pressure decline and essentially the overall pay-zone permeability (derived from productive indices of well if preferred)—an **optimum** figure for well spacing may be derived. This optimum merely means that, under the economic conditions prevailing, a well density either greater or less than the optimum will result in a decreased economic recovery; and, in the last analysis, in any practical operating system it must be found that economic efficiency is synonymous with efficiency in any terms it may be desired to clothe it.

Although, on the basis of the known production phenomena already referred to, the spacing problem is so elusive as actually to appear non-existent—and certainly impossible to evaluate—the economic factor provides a real criterion and a direct solution. Optimum well-density figures derived on this basis provide spacings sufficiently close to qualify adequately the term "reasonable," and to eliminate any physical questions regarding the ability of the wells to recover the oil. Thus an economically derived well spacing provides a solution to the problem and adequately encompasses the ideas of conservation, which admittedly must be a primary consideration.

Finally, it is of interest to note that already in secondary-recovery water-flooding operations the well spacing problem, once an outstanding physical question, has been relegated to the economic phase. For apparently it has been found that an economically sound spacing program provides a density of wells sufficient to eliminate any serious questions regarding efficiency in recovery.

For purposes of completeness it seems necessary to make the trite qualification that if from adequate data regarding reservoir factors it is known that the reservoir comprises discrete non-connected lenses, then evidently the number of wells should be sufficient to provide penetration of each lens. However, it appears from the reliable data obtained from numerous reservoirs in recent years that alteration of an economically derived spacing program seldom would be necessary.

Summary

Any consideration of factors affecting reservoir performance requires first a definite commitment concerning the basic principles underlying the performance without which elaboration upon details is

meaningless. Thus the foregoing discussion dwells at some length upon this phase of the question. The concepts of reservoir mechanisms which have been outlined represent, in the writer's opinion, the accepted modern views. On this foundation the more important factors involved, together with some related details, have been reviewed. Other factors not considered here, and their role in the performance, will be evident in the light of the fundamentals as outlined. In view of the general scope of the discussion, no attempt has been made to outline techniques for determining factors other than in those instances when proper emphasis has required it.

Acknowledgment

The author wishes to express his appreciation to Dr. P. D. Foote, of the Gulf Research and Development Company, for permission to publish this paper; and also to emphasize that the material presented here represents his opinions, and is not intended to reflect the views of the above organization.

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Fluor Corp., Ltd. Continues Expansion

By action of its Board of Directors, The Fluor Corp., Ltd., through J. S. Flour, Jr., announces two important additions to its facilities in an expansion move which will provide an added wing to the company's main office building to house its expanding engineering department and the construction of a new building to house the company's new research development laboratory. The addition of the wing to the parent building marks the third such addition to the structure and the second addition to the engineering department wing since the company occupied its new office building in September 1940.

According to executives of the company, the erection of the new research and development laboratory building marks an undertaking long planned to widen and round out the company's scope for service to the oil and gas industries. Facilities will be provided for the observation and study of the behavior of gases under high pressures and for the study of the many complex problems of modern refining processes, particularly those of isomerization and alkylation. Likewise, studies of the problems related to recovery of natural gasoline and light hydrocarbon fractions from field gases, gas treatment and gas cleaning will be undertaken.

The building will contain the latest and most modern laboratory equipment and a feature will be an air conditioning system for the maintenance of constant temperature control at 77°F., plus or minus 2.5°F. A dog-leg, concrete apron 15' x 8' x 80' will provide a foundation platform where pilot plants can be erected at will to carry into commercial practice the experimental work conducted in the laboratory. Also included will be a steam plant to provide 150 lb. working pressure steam for general research work. The initial expenditure for the building and laboratory equipment will be $25,000.00. Research and development will be under direction of A. J. L. Hutchinson, chief process engineer, assisted by Ira C. Bechtold. F. W. Bell and Ernest Moncrief.

The engineering department wing, to be added to the parent office building at a cost of $10,000.00, will provide added office space for additional draftsmen as well as a number of private offices for engineering department. Construction of this unit, as well as the research and development laboratory building, is under way with completion scheduled for April.

Tide Water Completes Baldwin Hills Project

With bottom at 8355 ft. and water string cemented at 7810 ft., Tide Water Associated Oil Co. completed Vickers No. 71 as one of the big producers in the Inglewood deep zone. Initial production was rated at 1819 bbls. a day of 29 gravity oil and 1,835,000 cu. ft. of gas through a 32/64-in. orifice. Flow pressure approximated 1000 lbs. and casing pressure quickly built up to 2800 lbs.

Producing 318 ft. of the deep zone to 8353 ft., Standard Oil Co. brought in Vickers No. 2-14 but no gauges were available at this writing. Jergins Oil Co.'s Howard No. 3, last of the present crop of drillers, is completing with bottom at 8445 ft.

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Reaction Chambers on Thermal Cracking Units

R. C. Mithoff* and L. F. Schimansky*

Ed. Note: The following, taken in part from a recent A.P.I. paper, is indicative of our California Petroleum industry's continuous efforts to lower cost of production —now more important than ever.

Thermal cracking units employed by the Standard Oil Company of California about 10 years ago were equipped with primary flash chambers or evaporators. The top transfer oil from the furnace was discharged, without quenching, into the evaporator wherein the vapor-liquid were separated. The overhead vapor passed directly to the fractionating column. Sufficient liquid was maintained in the evaporator to seal the bottom draw. The heavy liquid oil from the evaporator bottom passed to an auxiliary flash system. The evaporator operated at a temperature such that appreciable cracking occurred therein.

Different units, otherwise essentially identical, were equipped with evaporators ranging in size from vessels 5 ft. in diameter and 37 ft. high to vessels 10 ft. in diameter, 30 ft. high. It was observed that the units equipped with larger evaporators tended to produce more volatile gasoline of higher octane number, and were of higher capacity, than the units equipped with small evaporators. This effect was attributed to the increased amount of cracking that occurred outside of the furnace coil in the units equipped with large evaporators.

A program of laboratory experimental cracking was performed to investigate these factors. The expected effects were strikingly confirmed; i. e., coil-and-chamber cracking produced more volatile gasoline of higher octane number, and the unit capacity was greater, than in the case of coil-only cracking.

A commercial unit next was equipped with a small auxiliary downflow reaction chamber. A test program was performed with the vessel in and out of service, and the anticipated effects of the chamber were confirmed again. Since then the Standard Oil Company of California has installed auxiliary reaction chambers on eight cracking units. The different chambers have been in service from one to five years, and extensive commercial test data on them have been obtained.

This paper presents a brief summary of the effects on plant operation and product quality that resulted from installation of the auxiliary chambers.

* Standard Oil Co. of California, San Francisco, Calif.
An A.P.I. Paper.

Theory of Reaction Chambers

Cracking stock processed by the Standard Oil Company of California is substantially heavier than are most of the stocks processed in the East. At different times residuums from California crudes have been cracked—these ranging in Saybolt Universal viscosity from 125 to 2,500 sec. at 130 deg. F. and in API gravity from 14 to 23 deg. The average for these residuums is a Saybolt Universal viscosity of about 800 sec at 130 deg. F, and they contain approximately 45 per cent of 70-penetration asphalt. This means that, with this California stock, more cracking occurs in the liquid phase than occurs with the lighter Mid-Continent or eastern stocks; and that also, with this California stock, furnace-tubing coking is more severe than with the lighter Mid-Continent and eastern stocks.

In a cracking unit operating without a reaction chamber, furnace conditions severe enough to obtain the desired conversion of the vaporized gas-oil component of the charging stock overcrack the heavy constituents that remain in the liquid phase in the tubes.

One method often employed to offset this disadvantage is two-coil operation, wherein a side cut from the vapor column is circulated through a light-oil cracking furnace. However, most California charging stocks do not produce sufficient oil of appropriate boiling range for recirculation to the light-oil furnace. This situation is aggravated further by the fact that lean naphtha (often containing less than 80 per cent of gasoline) must be produced in order to supply cutter stock for the heavy cracked residuum that is produced from most California charging stocks.

Use of a downflow reaction chamber on a single-coil unit effects many of the advantages of two-coil operation, without the foregoing disadvantage, when heavy oil is charged. The top transfer oil from the furnace is a mixture of liquid and vapor, and is discharged at essentially full cracking temperature into the top of the reaction chamber. The liquid constituents flow rapidly down the walls or fall through the vapors, under the influence of gravity, to the bottom of the vessel, and promptly are ejected therefrom in the combined liquid and vapor stream. However, the vaporized constituents of the oil from the furnace top transfer line drift slowly downward through the vessel, being forced forward only as additional vapor enters the top of the chamber. This situation results in exposure of the vapor in the chamber to cracking conditions for a period several times longer than exposure of the liquid. This means that, in the unit as a whole, the vapor is cracked appreciably more severely than in the asphalt —which is one of the main objectives of two-coil operation.

Use of a reaction chamber, therefore, allows the over-all degree of cracking in the unit to be increased without undue coking, because the chamber permits increase in the severity of cracking of the low-coke forming gas oil, without increase in the severity of cracking of the high-coke-forming asphalt. This results in increased unit capacity gasoline of im-

CNAGA SECOND ANNUAL GADGET-KINK CONTEST

As a result of the success of the first joint Los Angeles-Taft Chapter Gadget and Kink Contest held in May of last year, the California Natural Gasoline Association is planning a similar meeting again this year, to be held some time in April. The widespread interest in these meetings is evidenced by the attendance of more than 200 at Lebec Hotel last year to see over 70 entries of all types of devices and ideas designed to save labor, money or make for greater safety in the natural gasoline industry.

Details for the meeting are now being worked out and announcement will soon be made of contest rules which, with some changes to simplify procedure and judging, will probably be similar to those of last year. It is anticipated that gadgeteers contemplating making one or more entries will plan to complete work on their gadgets soon in order that there will be no undue delay in preparing and submitting their entry forms which should be ready for distribution by the Secretary on or before March 1, 1942.

At the suggestion of Natural Gasoline Association of America plans are being considered for a joint NGAA—CNGA Gadget-Kink Contest to follow the CNGA Meeting. This event will provide an extra incentive for those interested to bring out the best they have at the April meeting in order to qualify among the limited number (possibly not more than five from each Association) eligible to compete for the additional, substantial cash prizes.

proved quality, and cracked residuum of lower sediment content.

Use of a reaction chamber decreases the proportion of the total cracking that must be done within the furnace coil. This markedly decreases the amount of coke deposited in the tubes, especially as it is in the later stage or coke-forming part of the cracking reaction—during which, in many cases, coke formation is heaviest—that coke is formed in the reaction chamber. Coke formation in the chamber is less harmful to economical operation of the unit than is coke formation in the furnace tubes, because more coke can be deposited in the chamber before a shutdown for cleaning is required.

Installation of a reaction chamber changes the cracking reaction from a short-time high-temperature process (as in coil-only operation) to a long-time lower-temperature process. This increases the amount of polymerization of olefinic components, especially those within the gasoline boiling range. The primary cracking reaction is endothermic, and polymerization is exothermic; hence, the chemical heat of reaction in the overall cracking process is reduced by installation of a chamber—and this results in increased plant capacity. The increase in polymerization also may account in part for the improvement in the octane number of the gasoline.

Use of reaction chambers decreases the net heat requirement for cracking more than can be accounted for by decrease in the chemical heat of reaction. This is due to increase in volatility of the naphtha and cracked residuum—which lowers the temperature at which the cracked products leaves the unit. * * *

Although use of reaction chambers is believed to increase the amount of polymerization that occurs in the unit; nevertheless, the yield of butenes per barrel of cracked gasoline is essentially unchanged. The reason for this is not clear, although it may be that in this regard the increase in polymerization is offset by the increase in severity of cracking of the gas oil.

The effects of reaction chambers described hereinbefore are truly a result of change in the time-temperature relation for the gasoil and asphalt components of the furnace feed. Complete correlation of the effects of the chamber, of course, would have to include calculation of the change in time-temperature relation for both of these components. This calculation, however, would be laborious; and its accuracy would be questionable. A simpler correlation factor is desirable.

After trial of many different factors for this purpose, it was found that the quotient of the volume in which cracking occurs outside of the furnace divided by raw-feed rate correlated quite well with all of the observed effects of addition of chambers. Numerically, this quotient is the sum of the volume of the reaction chamber, in cubic feet; plus one-half of the volume of the evaporator, in cubic feet; divided by the raw-feed rate, in thousands of barrels per day. These units were adopted to give a factor of convenient numerical size. It is designated herein as V/R. In this expression, evaporator volume was assigned only one-half the effectiveness of reaction-chamber volume; because it was observed, in commercial operation, that the evaporator operated at lower temperature than did the reaction chamber, the difference being such that about one-half of the reaction rate would be expected.

The relation between severity of cracking of the gasoil and asphalt is also dependent upon the shape of the auxiliary reaction vessel employed. The time that the gas oil spends in the vessel is dependent upon the volume of the vessel; whereas the time that the asphalt spends therein depends upon the distance that it must fall within the vessel, i. e., upon the height of the vessel. The ratio of height to diameter of all of the reaction chambers employed by the Standard Oil Company of California is within the range of approximately 6:1 to 8:1. This range is too small for the shape factor to be perceptible in results obtained from the cracking unit. However, chambers of markedly different relative dimensions may give results appreciably different from those presented herein.

It is realized that use of the correlation factor V/R leaves much to be desired. However, the results obtained by its use were sufficiently accurate for solution of the engineering, process, and economic problems involved; and the laborious calculations based upon a sounder theoretical background could not be justified.

As an example of the reduction in heat requirement obtained in commercial practice, the Standard Oil Company of California installed 8-ft. x 50-ft. reaction chambers on 4 units, each with a daily feed capacity of approximately 8,000 bbls. Installation of the chambers increased the V/R from about 50 to about 300. Test data shows that the heat requirement was decreased about 17 per cent.

The following tabulation indicates the heat requirement before and after installation of the chambers:

	Without Chamber	With Chamber	Decrease
	(Btu Per Bbl of Raw Feed)		(%)
Heat differential:			
60 deg. to raw-feed temperature of 140 deg. F.	14,000	14,000	..
Absorbed in raw-feed - naphtha heat exchanger	20,000	17,000	..
Absorbed in furnace.	166,000	135,000	19
Total requirement above 60 deg. F...	200,000	166,000	17

This particular installation saved about 31,000 Btu in furnace-heat absorption per barrel of raw feed, which, at 70 per cent furnace efficiency, corresponds to a saving of about 7 bbl. of fuel per 1,000 bbl. of cracking stock processed.

Capacity of Unit

It has been the experience of the Standard Oil Company of California that the maximum annual through-put and the minimum operating and maintenance cost per barrel of gasoline are obtained if the cracking plant is operated at a high feed rate, such that tube coking necessitates shutdowns for cleaning after runs of about 700 hours. The rate of tube coking in a given furnace is dependent upon the total heat absorption therein; hence, a reaction chamber increases the capacity of a given cracking unit due to the decrease in the required heat absorption per barrel charged.

In addition to the above factor, a reaction chamber transfers the more severely coke-forming part of the cracking reaction to a point outside of the furnace tubes. This permits a given furnace to absorb more heat per hour, for a given rate of coke deposition, if a unit with a reaction chamber is used than if no chamber is employed. This factor permits a greater increase in the raw-feed rate to be made when a chamber is installed than would be anticipated on the basis of the decrease in heat requirement alone.

In the example cited previously, viz., installation of an 8-ft. by 50-ft. chamber on an 8,000-bbl.per-day unit, V/R was increased from 50 to 300, and the raw-feed capacity was increased 27 per cent (up to 10,200 bbl. per day) for operation at constant naphtha yield and gasoline content. This corresponds to an increase of 27 per cent in the daily gasoline-producing capacity of the unit.

When heavy California residuum is charged, a unit such as described makes its maximum daily gasoline production at approximately 80 per cent gasoline content in naphtha (400-deg-F-end-point gasoline) with V/R=50 (without reaction chamber), and at approximately 100 per cent gasoline content with V/R=300 (with chamber). The attempt to produce more volatile naphthas than these—whether by an increase in the proportion of the mixed feed going to the upper part of the vapor column or by the recirculation of naphtha to the top of the column—always results in a marked decrease in the gasoline-production rate. Use of a reaction chamber is, therefore, an economical means both of increasing the gasoline content of naphtha and raising the gasoline yield.

In the example cited previously, i. e.,

in which an 8-ft. x 50-ft. vessel was added to an 8,000-bbl.-per-day unit, the feed rate would be increased 16 per cent, or to 9,300 bbl. per day; the gasoline content of the naphtha would be increased from 80 to 100 per cent; and the daily production of gasoline would increase 45 per cent, as compared with an increase of only 27 per cent if the naphtha quality were maintained constant.

The refinery demand for light gasoil cutter stock determines which of the above alternatives will be used in any given case to realize the advantages resulting from installation of reaction chambers. In many cases the most advantageous results may be obtained at some intermediate point.

Quality of Cracked Products

Use of reaction chambers decreases the severity of cracking of the heavy asphalt constituents of the charging stock. This means that the asphalt is less severely viscosity-broken, and the viscosity of the cracked residuum for a given naphtha yield is increased. A charging stock with a Saybolt Universal viscosity of 800 sec. at 130 deg. F, if cracked to yield 35 per cent naphtha in a unit of 50 V/R, produces a cracked residuum with a Furol viscosity of approximately 400 sec at 122 deg. F.; whereas in a unit of 300 V/R the Furol viscosity of the residuum is about 580 sec. at 122 deg. F. for the same naphtha yield.

California refiners often encounter some difficulty in meeting the viscosity specification of the different cracked fuels sold, due to the high percentage of heavy ends in most California crude oils. The decrease in degree of viscosity-breaking is, therefore, an undesirable factor in the use of reaction chambers; however, this usually can be offset by other feasable changes in the refinery stock balance. This problem would not exist in refineries processing lighter crude oils.

Use of reaction chambers also appreciably decreases the sediment content of the cracked residuum produced at a given yield of cracked naphtha. This effect is probably due to the decrease in severity of cracking of the asphalt component of the charging stock.

Cracking units equipped with reaction chambers produce gasoline of higher volatility than do units without chambers. The spread between the 50- and 90-per cent points is increased, the spread between the 20- and 50-per cent points remaining essentially unchanged. For example, installing an 8-ft. x 50-ft. chamber on an 8,000-bbl.-per-day unit lowered the 20 and 50-per cent points of gasoline of a given 90-per cent point by about 6 deg. F.

Chambers also increase the octane number of the cracked gasoline, due in part to the increase in volatility and, in part, to change in chemical character of the gasoline.

In none of the tests performed by the Standard Oil Company of California was it found that the use of reaction chambers caused any detectable change in the sulfur content, amount of acid required for finishing, or in the lead susceptibility of the cracked gasoline.

Improvement in Plant Operation

A reaction vessel serves as a surge chamber to absorb fluctuations in the operation of the cracking unit. A unit equipped with a reaction chamber is substantially easier to operate and control than a unit not so equipped. Abrupt variations in feed quality or in top transfer temperature are less likely to coke the tubes, because the coke-forming part of the reaction occurs primarily in the chamber. Uncontrollable "swings" in the operation are also substantially less likely to occur.

It is, therefore, possible to operate a unit with a chamber substantially closer to its maximum theoretical capacity than a unit without a chamber. Shutdowns for cleaning because of coke which formed during accidental "swings" are less frequent. Standard Oil Company records show that the installation of chambers improved the equivalent operating factor of the unit about 5 per cent for the foregoing reasons. This improvement in operating factor resulted in a 5-per cent increase in the annual plant throughput over and above the increase in maximum theoretical capacity.

Economics of Reaction Chambers

Use of reaction chambers effects an appreciable saving in the unit manufacturing cost of the gasoline. The unit labor cost is reduced, because the plant capacity is increased without increase in the number of men required to operate the plant. The fuel cost is decreased, because the net heat requirement of cracking is reduced, and because the furnace usually can be operated at higher efficiency. A small saving in cooling water is made, because the products leave the unit at lower temperature.

Standard Oil Company of California experience has been that the annual maintenance cost for a given unit is essentially the same whether a chamber is employed or not. Hence, the maintenance cost per barrel of gasoline is decreased approximately in proportion to the increase in plant capacity.

The increase in octane number of the cracked gasoline can be utilized either by a decrease in the amount of tetraethyl lead, or by diversion to some other gasoline—in which their value may be greater —of other high-octane stocks used in the final gasoline blend. The increase in volatility of the cracked gasoline may be utilized by a decrease in the volume of natural gasoline employed in the refinery, or by other readjustments in the refinery stock balance.

Use of chambers decreases the degree of viscosity-breaking obtained in the unit, but it is difficult to evaluate financially the penalty that may result from such decrease in viscosity-breaking. No penalty would exist in refineries that process light crudes. In refineries that process heavy crudes and that are short of light gas oils, detailed analysis of the entire refinery stock balance is required to find means of offsetting the decrease in viscosity-breaking resulting from use of chambers.

In analyzing the economy of installing reaction chambers on new or existing cracking units, study must be made to ascertain if the advantages of these chambers are truly realizable in the particular refinery stock situation in question. For example, if the chambers were to be installed on existing units, and if no increase were required in the daily cracked-gasoline production in the refinery, it is possible that little saving in unit operating cost would be made, unless one or more of the units could be shut down as a result of the increased capacity of the others. Similarly, little credit could be taken for improved volatility of the cracked gasoline unless it were possible to decrease the refinery input of natural gasoline.

In all of the installations of reaction chambers made by the Standard Oil Company of California, it was found possible to take full advantage of all of their favorable effects described hereinafter. Other means were found to offset the disadvantage of reduced viscosity-breaking.

Reaction Chambers vs. New Units

When a refinery stock situation reaches the point where increase in the cracked-gasoline production is required, decision on the following factors is necessary:

1. Should a new cracking unit of the existing type be built.
2. Should the new unit include a reaction chamber.
3. Should reaction chambers be installed on existing cracking units.
4. What is the economical size of the reaction chambers to be installed.

Usually these questions resolve themselves into finding the cheapest way of obtaining the required additional capacity. If the required increase in gasoline production is within the range of that attainable by the installation of reaction chambers on existing units, it is believed that this alternative is far cheaper than to build new units.

If, for example, an 8-ft. x 50-ft. vessel, costing perhaps $60,000, were installed on an existing 8,000-bbl.-per-day unit, the daily gasoline production therefrom

would be raised from about 2,300 bbls. to about 2,900 bbls., or an increase of about 600 bbls. per day (27 per cent), for constant naphtha yield and quality. The additional gasoline, therefore, would be obtained from an investment of only about $100 per barrel per day, as compared to $225 for construction of a new unit.

Construction of new units, of course, would be required if the necessary increase in gasoline production were larger than that attainable by the installation of reaction chambers on all existing units. Even in this case, however, consideration should be given to the attainment of at least part of the required increase in capacity by installation of chambers.

Analysis of each particular situation is required to determine the most economical size of reaction chamber to install on either the new or the existing units. If economic analysis shows that chambers would be desirable, it is believed that in most cases the vessels should be relatively large; i. e., of such size that a V/R of at least 300 to 400 is obtained. In the case of small cracking units it may be desirable to use a vessel giving a V/R substantially larger than this, as the incremental cost of obtaining the higher value of V/R may be relatively small.

Many cracking units in this country are equipped with reaction chambers that correspond to a V/R of 100 to 200. It is believed that in many cases it would be worthwhile to give consideration to the replacement of the existing chamber by another larger vessel, or to the installation of another vessel in parallel.

Conclusion

During recent years the Standard Oil Company of California has installed auxiliary downflow reaction chambers on most of its cracking units in service. Use of the chambers has resulted in increased plant capacity, improved product quality, and reduced cost. It is believed therefore, that installation of additional reaction chambers on many of the cracking units in use in this country would be advantageous.

Barbecue Funds Donated To American Red Cross

Oil Men's Barbecue & Golf Committee have decided to disband and are donating their funds to the AMERICAN RED CROSS.

These funds in the amount of $195.59 are all being donated to the American Red Cross for Relief Purposes.

This Committee operated under the name of: "Coalinga-Avenal-Kettleman Barbecue & Golf Tournament" and was organized for recreational purposes.

Members of the Committee were: J. B. Hill, chairman; C. T. Blanchet, treasurer; Johnny Hahn, Claire Morriss, George Metzger, Ogden Arnold, Harvey Davis, Ben Monnes, L. W. Ballard, Dan Berry, Ben Arlett.

So as to help the War Relief Chest, $100.00 of these funds is being allotted for this purpose, and the remainder of $93.59 is donated to the Red Cross Avenal Fund for direct relief and to be used locally for Red Cross work.

In view of the present emergency, disposal of these funds as mentioned above is being done in order to further the cause of our Democratic Way of Living.

Petroleum Accountants Dinner Meeting Jan. 22

The Petroleum Accountants' Society held its regular monthly dinner meeting January 22, at the Los Angeles Athletic Club.

L. Hartly Smith, head of the statistical department of Dean, Witter & Co., spoke on "The Outlook for the Oil Industry."

Chairman for the evening was Gordon D. Campbell, General Petroleum Corp. D. A. Moore, Wilshire Oil Co. is president of the society.

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THIS LAUGH OFF!!

Gus Wetzel picked this one up somewhere:

Old Negro Granny: "Dis is my grandchild and she wants a marriage license."

Judge: "How old is she?"

Old Negro Granny: "She is jus past 15."

Judge: "Sorry, but she can't have a license; she is too young to get married."

Old Negro Granny: "Lawdy mister jedge wat we gwyna do; she's ol nuf to do wat she's already done did."

Then, there was that newly married Bakersfield oiler who wired to his wife from San Francisco where he was attending the API. He wrote: "Having a swell time, wish you were here." The telegraph company left off the final "e", and he is still in the dog house.

And here is one recounted by **Holly Hayter:**

Lord Babbington was instructing a new colored servant in his duties, adding, 'Now, Zeke, when I ring for you, you must answer me by saying, 'My lord, what will you have?' "

A few hours later, having occasion to summon the servant, his lordship was astonished with the following:

"My Gawd, what does you want now?"

"Has that girl lost her dress, or am I seeing things?"

"Both!"

Roy Hitchcock passes this one on:

George Biddle Hoofstraw, a large, earnest black boy, having duly registered, was asked by the large, earnest white lady on the draft board whether he had any questions.

"Yessum," said Mr. Hoofstraw, "Which side is I on?"

A short section from a government publication telling housewives what to do in an air raid reads as follows: "Turn out the lights, pull down the blinds, get under the table, and cooperate with the air raid warden."

Narrator: "By the simple movement of a hand, that man puts thousands of men to work, and as easily dismisses them."

Listener: "What is he, president or superintendent?"

Narrator: "Neither. He blows the factory whistle."

An aged Scotswoman, writing her thanks for Bundles for Britain, gave an American woman this recipe for taking a bombing:

"When the air raid warning sounds, I take the Bible from the shelf and read the 23rd Psalm. Then I put up a wee bit prayer. Then I take a wee drap o' whisky to steady my nerves. Then I get in bed and pull up the covers. And then I tell Hitler to go to hell."

First Little Bird: "Who's that sitting on the bench?"

Second Little Bird: "Oh, it's that guy who shot at us the other day."

First Little Bird: "Well, what are we waiting for?"

"You never kissed so wonderfully before, Laura. Why is that? Because we are in a blackout?"

"No. It's because my name is Vera."

Names used on this page are entirely fictitious, and any resemblance to persons either living or dead is purely coincidental.

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Field Developments

Los Angeles Basin

La Bolsa Rancho Syndicate Drills Near Huntington Beach

La Bolsa Rancho Oil Syndicate has resumed operations in Crane No. 1 and is preparing to drill ahead after cementing surface casing at 518 ft. The well adjoins the Meadowlark golf course northwest of Huntington Beach.

Texas Co. to Test Anaheim Wildcat

With a possibility of discovering a new field a mile southeast of Buena Park on the main highway to Anaheim, The Texas Co. is preparing to make a series of tests in Spencer No. 1. With bottom at 9650 ft. near the Repetto-Miocene contact, the company plans to set the necessary casing to test four separate intervals below 8800 ft. which showed productive possibilities during the drilling. Should no production be obtained, the hole will be abandoned without further deepening.

Del Valle Outpost Tests Discouraging

In the westerly portion of Del Valle, Jack Herley and Paul Kelley's Videgain No. 2 and Ohio Oil Co.'s Vasquez No. 2 seem to suffer from the same complaint, namely, inability to produce oil.

The Herley-Kelley project continues to swab the interval 5902-5950 ft. but recovers little fluid. Ohio Oil Co. landed a perforated liner at 6243 ft., swabbed the hole practically dry, then pulled the liner and gun perforated the formation below the casing shoe at 6195 ft. This failed to improve the situation and the hole is being deepened below 6279 ft.

Best looking well now working is Standard Oil Co.'s Sepulveda No. 2 which is preparing to complete at 5838 ft. after exhaustively testing nearly every foot of hole below 5680 ft. Results obtained in this experimental well will prove a guide for future drilling.

Del Valle Outpost Flows on Stem Test

Lending encouragement for the east end of Del Valle, R. E. Havenstrite, Operator, obtained a 67-bbl. a day flow of 40 gravity oil cutting 11.0 per cent and 824,000 cu. ft. of gas on a formation test of Liebhart No. 1. Most easterly well in the field, the hole was drilled to 7255 ft. bottoming in gray sand. A blank liner was cemented at 7150 ft. and first gun perforated from 7070 to 7096 ft. where a flow of 20 bbls. of light oil and 810,000 cu. ft. of gas

LOS ANGELES BASIN WILDCATS

Area	Well	No.	Section	Depth	Status
Castaic	Mangold & Morse Oil Co., McDermott	1	26, 5-17	2667	Drilling
	Young, Roy, W., Inc., Walker	1	11, 4-16	7461	Drilling
	The Texas Co., Fernando	1	11, 4-17	8034	Abandoning
Newhall	Barnsdall Oil Co., Limbocher	1	17, 3-16	7056	Drilling
	Willis & Assoc., Ferguson	1	30, 6-17	6857	Drilling
Palmdale	Wesco Const. Co., Well	1	20, 5-9	2736	Drilling
Palos Verdes	Surety Holding Co.	1	22, 5-14	1191	Idle
Puente Hills	Axis Pet. Co., Tandberg	1	13, 2-11	3500	Testing
Puente Hills	Axis Pet. Co., W. R. Rowland Ranch	1	21, 2-10		Bldg. rig
	Continental Oil Co., Turnbull Comm.	2	13, 2-11	3792	Redrilling 3370
Rio Hondo	Potrero Oil Co., Well	1	32, 1-11	7370	Stuck D.P.
San Fernando	Fernando Oils. Ltd., Chatsworth	1	18, 2-16		Rig
	Shell Oil Co., Mission	2-1	25, 3-16	5297	Drilling
	Tide Water Assoc., Mission	1	26, 3-16	8899	Fishing D.P.
	Tide Water Assoc., Sesnon	1	28, 3-16	1289	Drilling
West Whittier-Rideout Hts.	Bell View Oil Synd. "P"	1	17, 2-11	1066	Drilling
Whittier-La Habra	Los Nietos Valley Oil Co., Woodard	1	29, 2-11	50	Idle
	Union Oil Co., Sansinena	13	30, 2-10	4143	Plugged 2627 Rigging pump
	Orange County				
Anaheim	The Texas Co., Spencer	1	1, 4-11	9650	Prep. to test
Bolsa Chica	La Bolsa Ro. and Synd., Well	1	22, 5-11	518	Drilling
Costa Mesa	Thompson, Milton N., Banning	1	9, 6-10	5649	Fishing D.P.
Kraemer	Atlas Oil Co., Kraemer	1	36, 3-9	2675	Idle

was obtained. Holes were then shot from 7043 to 7011 ft. and the test made which resulted in the 67 bbl. flow.

Havenstrite's Lincoln No. 9 is coring heavy black oil sand at 7080 ft. after making a test at 6894 ft. which recovered salt water. Lincoln No. 10 which encountered much faulting has temporarily suspended at 7255 ft. in shale streaked with heavy oil sand.

Decker et al, Dominguez Project

Tests, so far, in Decker, Osbourne & Associates' southwest Dominguez outpost have been somewhat disappointing in that little fluid has been recovered. Bottomed at 7740 ft. and with a combination liner cemented through perforations at 7702 ft., the hole was swabbed for several days with only a little oil and salt water entering. When last reported, an attempt was being made to pull the tubing which had been set on a packer. After recovering the tubing, it is planned to acidize the formation and retest.

On the north flank of the field west of Avalon Blvd., Oceanic Oil Co. has the cellar dug for a semi-wildcat well on the Condren property.

G. P. Completes Ford Zone Well

Perhaps the last Wilmington Ford zone well for the duration was recently completed by General Petroleum Corp. when Ford No. 41 was brought in flowing 1135 bbls. a day. Located in the highest part of the field, the well utilizes 645 ft. of formation from 4705 to 5350 ft.

In the northwest Wilmington area, two wells were completed in the past fortnight for better than average yields. Barnhart-Morrow Consolidated Sherman No. 2 at the northeast corner of "M" and McDonald Sts. came in flowing 250 bbls. a day and settled to approximately 185 bbls. cutting 3.5 per cent. Perforations are open at intervals from 2950 to 3715 ft.

Texas Abandons Castaic Wildcat

Finding nothing of importance to 8034 ft., The Texas Co. abandoned Fernando No. 1 near Castaic. The project was located in the northwest quarter of sec. 11, 4n-17w about a mile north of the east end of the Del Valle field but on a different structure.

Carefully cored most of the way, the well encountered many sand bodies from the lower section of the Pliocene to bottom but none were oil saturated. Rumor has it that

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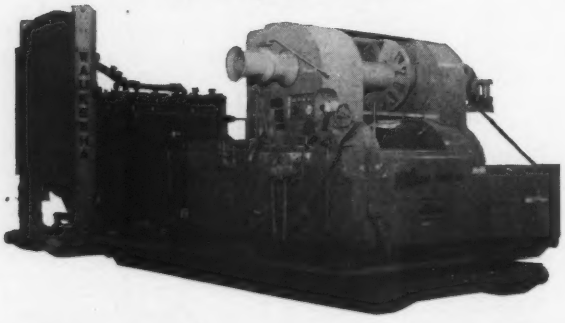

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results indicate the hole was located on the easterly plunge of the anticline and that a new well to the west should encounter the sands at a higher level with correspondingly greater chances of being productive. The Texas Co. controls a large amount of acreage in the vicinity but has not yet abandoned plans for further work.

North of the abandoned well, in sec. 26, 5n-17w, Mangold & Morse Oil Co. deepened McDermott No. 1 to approximately 2700 ft. where, at last reports, oil was being spotted to loosen stuck drill pipe.

North of Saugus, in sec. 11, 4n-16w, Roy W. Young, Inc., is drilling Walker No. 1 in fractured shale at 7500 ft.

Newhall Wildcat Cores Oil Sands

Hottest wildcat in California is C. G. Willis & Associates' Ferguson No. 1 which cored sufficient oil bearing formation to 6857 ft. to convince many competent observers that it will make at least a small well.

Located near the center of sec. 6, 4n-17w approximately 7000 ft. southeast of production in the Newhall-Potrero field, the well topped a sandy horizon at 6700 ft. which appears closely similar to the First Zone in the field. Much of the zone was quite hard and tight but many streaks of loose, friable, pebbly sand of good permeability and saturation were encountered.

Most encouraging feature of the well to date is the fact that the First Zone looks so good, even though estimated to be 125 ft. lower on a sea level basis than Barnsdall Oil Co.'s nearest well, Rancho San Francisco No. 14. Within the established field, the main producing horizon is the Third Zone whose areal extent is greater than the First and from which production is much greater. This zone has not yet been reached in the Willis well and there is much reason to hope that it will be as good here as in wells situated on the same sub-sea contour within the field.

Because of a tendency of the walls of the hole to pinch and hang up the bit while making round trips with the drill pipe, a string of 7-in. casing was cemented on bottom at 6857 ft. At this writing, cement is being drilled out preparatory to coring ahead for a look at the Third Zone before making a production test.

New Wells Improve Turnbull Outlook

Recent developments in the active wells have greatly improved the outlook for the newly discovered Turnbull Canyon field. Formation tests have proved the existence of a prolific gas sand and indicated probable oil production in Axis Petroleum Co.'s Tandberg No. 1 and a directional redrill job has virtually assured production for Continental Oil Co.'s Turnbull Community No. 2.

Drilled two-thirds of a mile northwesterly from the discovery well, Turnbull Community No. 1, the Axis project found its first oil sands at 2880 ft. which, opened to 2981 ft., yielding 5½ stands of mud and 23 gravity oil on an hour's formation test. Prospected ahead to 3474 ft., the well encountered good looking sands which, on trial with the tester set at 3325 ft., blew gas at a daily rate estimated between 2,500,000 cu. ft. and 5,000,000 cu. ft. A trial was then made of the interval 3393-3474 ft. which resulted in a heading gas blow estimated at 150,000 cu. ft. and a recovery in the drill pipe of eight stands of oil and drilling mud. Deepened to 3500 ft. in conglomerate showing oil, a fourth test with the packer set at 3436 ft. and the valve opened an hour, recovered six stands of mud and oil with a little fresh water.

Though the oil horizons are encountered at approximately the same depth in this and the Continental Oil Co. wells, no satisfactory correla-

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tions can yet be made between the two areas.

Finding no oil sand in vertically drilling Turnbull Community No. 2 to 3792 ft., Continental Oil Co. plugged to a shallow level and re-drilled directing the hole to the north. Oil sand was topped at 3295 ft. in the new hole which continued to last reported bottom at 3370 ft. Lack of oil sand in the straight hole is explained by the presence of a fault which is now definitely shown to be a major control of the productive area.

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Axis Pet. Starts 2nd Puente Project

Two miles east of the Turnbull Canyon wells and on a separate structure, Axis Petroleum Co. has foundations in for a new wildcat well on Rowland property. Location of the project, which is scheduled for immediate drilling, is near the west quarter corner of sec. 21, 2s-10w.

Towsley Canyon Well Reports Oil Showing

Limbocker No. 1, joint test of Barnsdall, Bandini and Ambassador companies in sec.17,3n-16w, reported very hard, tight sand showing a little oil in the interval 6600-6850 ft. but of insufficient quantity to warrant testing. The hole is being drilled and spot cored below 7060 ft. and, unless prospects improve, will probably be abandoned in the near future. The well is located in Towsley Canyon near the crest of a very sharp anticline.

Bell View Syndicate Drills Rideout Well

Seeking shallow tar zone production in the old Rideout Heights-West Whittier field, Bell View Oil Syndicate is drilling "P" No. 1 near the intersection of Workman-Mill Road and Lemon Ave. When last reported at 1066 ft., the well had cored a few streaks of tar sand but had not uncovered anything of commercial value. Exploration below 1500 ft. is not contemplated.

Tide Water Completes Deep Aliso Producer

Flowing initially 15,000,000 cu. ft. of gas with a white spray of 51 gravity condensate and drilling water, Tide Water Associated Oil Co. brought in Porter No. 26 as the second producer in the Aliso Canyon deep zone. Beaned back through a 48/64-in. orifice, production now gauges 142 bbls. of 48 gravity condensate and 8,500,000 cu. ft. of gas. Located beyond the westerly limit of the 5000 ft. zone production, Porter No. 26 was finished at 7844 ft. with 6⅝-in. casing cemented at 7610 ft. and a perforated liner landed on bottom.

Cinderella well of the field is Universal Consolidated Oil Co.'s Ward No. 1 which is now being completed as a northerly offset to the discovery section of the field. Abandoned three years ago by Standard Oil Co. at 6909 ft. when the upper sands were found missing due to faulting, the hole stood idle until re-entered by its present owner two months ago. Meanwhile Tide Water Associated's Porter No. 12 explored to depth and found the high pressure gas and condensate horizon. Universal Consolidated is bringing in Ward No. 1 after deepening to 7665 ft. and setting 7-in. casing over the deep sand at 7425 ft.

West of Aliso Canyon, Tide Water Associated Oil Co. and Standard Oil Co. are drilling their joint wildcat, Sesnon No. 1, below 1300 ft. This well is located high in the hills at an elevation of 3129 ft. above sea level, an unusual altitude for California operations.

Both wildcats east of Aliso Canyon continue to drill with little encouragement reported of late. Shell Oil Co.'s Mission No. 2-1 has passed the 5300 ft. mark while Tide Water Associated Oil Co.'s Mission No. 1 is fishing at 8899 ft.

Western Gulf Seeks Oak Canyon Horizon

Western Gulf Oil Co. Lechler No. 3 at Oak Canyon is coring for the deep zone at 7010 ft. while the company's easterly outpost, L. W. Gilmour-U. S. No. 1 is having trouble maintaining circulation near the 1000 ft. level.

Wood-Callahan Finishes Second Torrance Pumper

Wood-Callahan Oil Corp. completed Dominguez Estates No. 2 in the northwest Torrance area pumping 70 bbls. of 15 gravity oil cutting 8.0 per cent. Bottom at 3710 ft., the hole is finished with a liner containing 400 ft. of pre-pack graveled perforations.

San Joaquin Valley

Pac. Western Getty Complete at Arvin

Pacific Western Oil Corp. and Geo. F. Getty, Inc. have completed Houchin No. 1 in sec. 27,31-29, south of the main Arvin area. The completion is but one location removed from the small production found by General Petroleum Corp.'s Houchin No. 1 in 1937, presently owned by Wood-Callahan.

Bottomed at 7409 ft. after finding the first oil at 7225 ft., 5½ in. casing was cemented at 7405 ft. with the water shut off OKed on holes at 7210 ft., the well was gun perforated in the interval 7225 to 7315 ft. and completed pumping 75 bbls. of 23 gravity oil cutting 30.0% water. Highest rate reported was 100 bbls. cutting 20.0% water.

Source of the water was located at the water shut off test holes which were squeezed with 16 sacks. Again on the pump, the well is making 40 bbls. of 23 gravity oil cutting only 8.0%.

Round Mt. Outpost Misses Vedder O. S.

F. H. R. Oil Co. abandoned well No. 1, sec. 2,28-28, in gray sand at 1906 ft. Located off the northwesterly tip of the Round Mountain field, the try found only one foot of oil sand in the top of the Vedder at 1850 ft.

Texaco Attempting New Gas Discovery

In an effort to add to gas producing reserves in the south-central San Joaquin Valley, The Texas Co. is reworking two 12,000 ft. abandoned holes in the Buttonwillow area.

First to show promise is S. P. No. 47-15, which the company drilled to 12,138 ft. in sec. 15,29-24 as an unsuccessful oil test, and which was abandoned without adequately trying shallow gas zones. Cleaned out to 4220 ft. for a trial of old perforations and with a formation tester with a ⅜ in. bottom hole bean set at 4172 ft., the well blew mud to the surface in 2 minutes followed by a moderate gas blow which cleaned the tester and marked up 1750 lbs. bottom hole pressure. Cleaned out to 4271 ft. the casing was perforated, 4 holes to the foot, from 4235 to 4262 ft. With 2½ and 1¼ in. tubing landed at 4221 ft. including a packer at 4171 ft., the well refused to blow by circulating and at last report the well was being swabbed.

In sec. 23,29-24 the company reentered and is preparing to test shallow gas zones not tried when Union Oil Co. drilled and abandoned it's Bowerbank No. 4-23 at 12,144 ft.

In this case the old hole was found junked and was redrilled to 4237 ft. where an electric log show-

SAN JOAQUIN VALLEY WILDCATS

Area	Well	No.	Section	Depth	Status
	Fresno County				
Helm	Amerada Pet. Co., Weyant	5–27	27, 16-17	8500	Testing
	Amerada Pet. Co., Clover	75–34	34, 16-17		Grading roads
	General Pet. Corp., Esperoad	75–33	33, 16-17	7624	Drilling
Jacalitos Hills	Wilshire Annex Oil Co.	21–26E	26, 3-15	3713	Completed
	Wilshire Annex Oil Co.	41–26E	26, 3-15	3773	Drilling
	Wilshire Annex Oil Co.	48–26E	26, 3-15		Prep. to spud
Kerman	Richfield Oil Corp., Ponte	1	30, 13-17		Rigging up
Raisin City	Barnsdall Oil Co., Ripperdan	1	24, 15-17	5161	Abandoned
	Seaboard-T.W.A.-Union, S.T.U.	86–13	13, 15-17		Foundation
	Shell Oil Co., Inc., S.A. & F.L.	31-19	19, 15-18	5077	Testing
Riverdale	Amerada Pet. Corp., Jensen	54–26	26, 17-19	6817	Testing
	Kern County				
Arvin	Pacific Western, Geo. F. Getty, Inc., Houchin	1	27, 31-29	7409	Pumping
Belridge—South	Ivy Drilling Co., Parkford	1	12, 29-21	1140	Cleaning out
	Sentinel Oil Co.	1	10, 28-20	3902	Idle
Buttonwillow	The Texas Co., S.P.	47–15	15, 29-24	12138	Swab. 4271
	The Texas Co., Bowerbank	4–23	23, 29-24	12144	Reaming 4275
Devils Den	Lang, Etienne, Occidental	2	30, 26-19	1255	Drilling
Edison	Getty, J. Paul, Portals Corp.	1	5, 30-29	4255	Sand. up-bailing
	Frazier, Finley & Assoc., Portals Corp.	1	4, 30-29	3888	Abandoned
McClung	Macrate, A. N., Haberfelde	1	32, 29-26	12035	Stdg. plugged
Mt. Poso	Alpha Oil Co., C. V. Elliott	1	1, 27-28	1315	Redrilling
	Bishop, Bradford, Well	2	22, 27-28		Grade
	R. R. Bush Oil Co., Rodgers-Jones	1	35, 26-27	1573	Drilling
	Vedder, D. G., Glide	23–1	23, 27-28		Location
	Union Oil Co., Villard	62–1	1, 26-27		Rig
Paloma	General Pet. Corp., Gallagher	61–33	33, 31-26	1814	Idle
	Ohio Oil Co., KCL A-10	41–4	4, 32-26	9156	Drilling
	Western Gulf Oil Co., L.A.A.C.	36–1	6, 32-27		Foundation
	Western Gulf Oil Co., Symons	12–7	7, 32-27	11705	Milling on iron
Richgrove	Bolling, R. S., Quinn	3	15, 25-27	2926	Milling on iron
	Shell Oil Co., Curry	1	20, 25-26		Rigging up
	Shell Oil Co., Smith Cairns	3	11, 26-27		Location
Round Mt.	F.H.R. Oil Co., Well	1	2, 28-28	1906	Abandoned
Shafter	Continental Oil Co., Neuman	1	36, 27-24	9949	Cementing csg.
	General Pet. Corp., S.P.	51–15	15, 28-24	13854	Drilling
Shale Hills	Tideland Oil Co., Grant Est.	1	4, 27-18	2660	Drilling
Union Avenue	Hancock Oil Co., Roberts	4	6, 30-28	5377	Pumping
	Richfield Oil Corp., Union Ave.	2	6, 30-28	5340	Pumping
	Kings County				
Dudley Ridge	Dudley Ridge O. C., Ltd., D.R.	3–16	3, 23-19	1207	Plugging
Pyramid Hills	Pacific O. & G. Dev. Corp., West Slope	2	20, 24-18		Location
	Tulare County				
Kingsburg	Goble, W. E., Goble	1	28, 16-23	1870	Abandoned
Terra Bella	Stout, Geo. W., Stout	2	11, 23-27	745	Pumping
Trico	Trico Oil & Gas Co., Lee	1	17, 24-23		Rig

ed promising gas zones. Deepened to 4275 ft. the try is at present reaming to make appropriate tests.

Fresno Developments Center Valley Interest

To a greater extent now than at any time since the early development of Coalinga is the interest of California oil men centered on Fresno County. Of the four discoveries made in the county during the past eight months, at least three will probably see considerable development during 1942 and the stimulus provided by their discovery will soon be reflected in increased wildcat activity throughout that portion of the San Joaquin Valley .

At this writing, Amerada Petroleum Corp. is preparing to test its second well in the Helm area, Weyant No. 5-27, located half a mile northwest of Clover No. 31-24 which was found productive last October in three intervals from lower Miocene at 7303 ft. to Eocene at 8005 ft. Situated in sec. 27, 16s-17e, the Weyant project is reported to have encountered the top of the Kreyenhagen Shale at 7500 ft. which is 50 ft. higher than the figure given for the same point in the discovery well. After penetrating Cretaceous approximately 300 ft. to 8500 ft., the hole was plugged and 5½ in. casing cemented at 8180 ft. preparatory to gun perforating and completing. If the same procedure is followed here as in the Clover well, the Eocene sands at 8000 ft. will be tested first after which trials will be made of Miocene sands at 7450 and 7300 ft.

It is hoped that the new well will prove to be a black oil producer instead of duplicating Clover No. 31-34 which is capable of flowing 13,500,000 cu. ft. of gas and 660 bbls. of 65 gravity condensate, as conditions discourage development of condensate fields at this time. In any event, further drilling will be required to outline the new field.

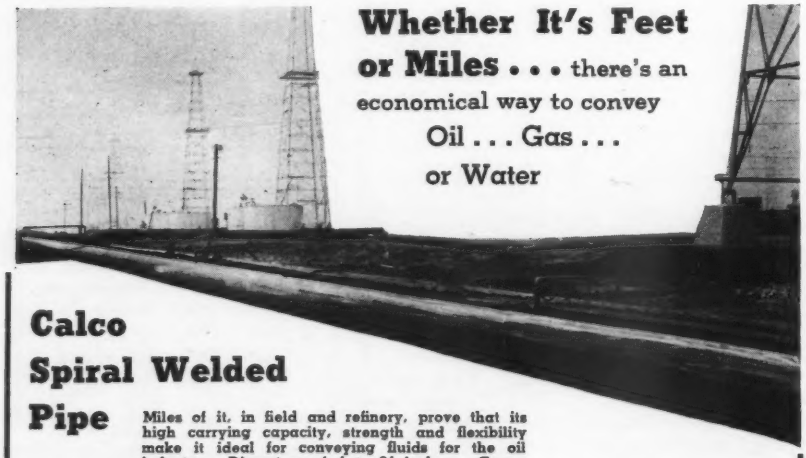
In sec. 33, 16s-17e, west of the discovery well, General Petroleum Corp. is drilling below 7700 ft. in Esperoad No. 75-33. This well will provide the third point for calculating contours on the productive horizons.

The second 1941 discovery which will require more drilling in the next few months is that at Riverdale where Amerada Petroleum Corp. completed Lawton No. 45-26 early in December flowing 560 bbls. of 34 gravity oil and 1,375,000 cu. ft. of gas through a restricted orifice. The company's second well, Jensen No. 54-26, is drilling ahead below 6800 ft. after making a formation test of the interval 6538-6638 ft. which resulted in a gas blow estimated at 15,000,000 cu. ft. If this correlates with the 6665-6685 ft. interval perforated in the discovery well, it can be assumed the structure rises to the northeast and increases the chances of finding production in the deeper sand phases which tested wet in the first try, drilled to 8311 ft. Both wells are located near the center of sec. 26,17s-19e.

Third of the new fields and one which can unquestionably be developed under present regulations is Jacalitos Hills where Wilshire Annex Oil Co. developed 100 bbl. production of 40 gravity oil last fall from the relatively shallow depth of 3700 ft. To date, the company has completed two wells in sec. 26,21s-15e with almost identical production rates, and is coring for the oil zone in a third. Very little gas accompanies the oil in this field and conditions are favorable for development under the one well to 40 acres rule. Insufficient drilling has been done as yet to indicate the size of the productive area but it is believed to be large enough to justify a number of new wells. In addition to No. 41-26E which soon will be on the completed list, Wilshire Annex is drilling No. 45-26E and has laid out paper locations for a full development program.

Raisin City, first of the series of Fresno county discoveries, is now at a standstill for two reasons. In the first place, results of outlying wells have not been encouraging for further extensions of present productive area and in the second place the one-to-forty regulation stops the drilling of inside locations, as development, so far, has been on a one-to-twenty basis. The thinness of the zones and consequent low ultimate recovery is also a discouraging factor.

At the present time, only one out-and-out wildcat is active in the county, that being Richfield Oil Corp.'s Puente No. 1 in sec. 30,13s-17e near Kerman. The drilling has been contracted to Bell & Loffland and the tools should be turning to the right within a few days.



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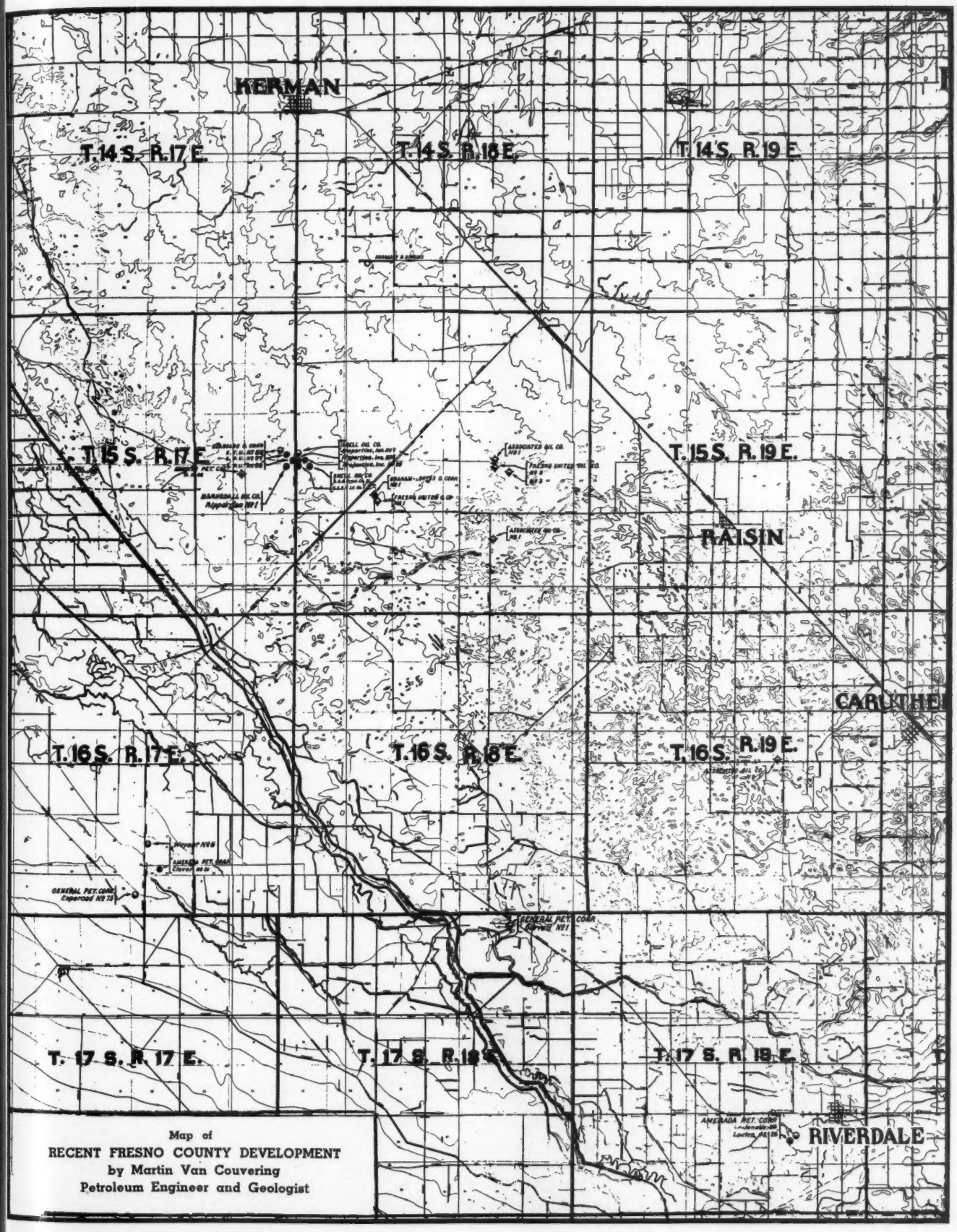
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RIVERDALE

Map of
RECENT FRESNO COUNTY DEVELOPMENT
by Martin Van Couvering
Petroleum Engineer and Geologist

Canal Deep Test Cores Oil Show

Shell Oil Co.'s try at Vedder zone production under the Stevens zone production in the Canal field received more slight encouragement when oil showings were reported in a core at 13,080 ft. The well, KCL No. A-44-14, which is drilling at 13,139 ft. in the center of the small Canal field on sec. 14,30-25, found the top of the usual Stevens sands near 8050 ft. Top of the Olcese was found at 11,400 ft. and a few oil showings in sands of low permeability were logged at 12,650 ft. These showings are thought to be the equivalent of the Upper Rio Bravo zone. Oil stained hard sands were also cored at 12,945 ft. At no time have the showings been strong enough to prompt optimism.

Edison Outpost Misses Oil Sands

Frazier, Finley & Assoc. Portals No. 1, an attempt to duplicate the sands recently proved productive by J. Paul Getty's strike a little more than a mile southwest of the try, is abandoned in conglomerate at 3888 ft, after coring poor oil sand in the main zone at 690 ft. Fingers of heavy sands were cored at 2118 ft.

Located just south of the Edison Station in sec. 4,30-29, the well appears to be in a separate and unproductive fault block.

J. Paul Getty's Portals No. 1, which was credited with a 1942 discovery in section 6, sanded up and is presently bailing. Last production was gauged at 45 bbls. of 19.7 gravity oil cutting only 0.4%, having diminished from an initial 175 bbls. through a 16/64 in. bean.

No. American Quits Deep Midway Test

Culminating an exhaustive series of tests in its 10,411 ft. south Valley try, North American Oil Cons. abandoned W. P. No. 1-28 in sec. 28,32-23 at the southwest flank of the Midway-Sunset field.

On the last production effort the well was plugged to 9343 ft. and shot with 30 quarts of nitro in the interval 9120 ft. Result of the blast was swabbed recovery of muddy water. Earlier trys have resulted in light gas blows and short heads of 38 gravity oil in varying quantities, none of which were considered commercial.

Shafter Well Near Objective

General Petroleum Corp.'s deep test on sec. 15,28-24 of the Shafter area is drilling and coring at 13,929 ft. in search of the Vedder. Slight oil showings were encountered near 13,850 ft. which are thought possibly to be the equivalent of the Wasco A-2 zone, a sandy phase overlying the top of the true Vedder. Last reported marker to definitely identify the wells geologic position was the Olcese at 11,850 ft.

In sec. 36,27-24 Continental Oil Co.'s Neuman No. 1, an attempt to better recently effected small production in the area, is repairing 9⅝ in. protective casing near 4500 ft. after reaching 9949 ft.

Union Avenue Wells Show Little Promise

Two current attempts to duplicate the substantial pumping production found by Hancock Oil Co. in sec. 6,30-28 are at present showing little indication of acomplishing the purpose.

Hancock's Roberts No. 4 on the discovery lease succeeds only in bailing and pumping a little mud and water showing traces of oil. Bottomed at 5377 ft., 7 in. casing was cemented at 5070 ft. after which the well was plugged to 5060 ft. and gun perforated from 5020 to 5035 ft.

Richfield Oil Corp.'s Union Avenue No. 2, successor to an unsuccessful 10,427 ft. try in 1938-39, was last reported pumping 12 bbls. of 13.8 gravity oil cutting 50.0% drilling fluid. Bottomed at 5340 ft. and plugged to 5204 ft. the well was gun perforated in the Roberts No. 1 zone at intervals from 4955 ft. to 5120 ft.

Reliance Regulator Executive Dies

Arthur C. Thompson, 52 year old, who has been vice president and general manager of Reliance Regulator Corp. since

Arthur C. Thompson

1918, died in the Pasadena hospital, Jan. 6. Mr. Thompson began his association with the Reliance Regulator Corp., Alhambra, Calif., when the company was taken over by his father, the late W. M. Thompson.

Ansul Chemical Appoints Petroleum Equipment Co.

The Ansul Chemical Co. of California has appointed Petroleum Equipment Co. as its exclusive distributor to the oil industry of California for Dugas fire extinguishing equipment and apparatus.

Petroleum Equipment Co., with headquarters in Los Angeles, its branch in San Francisco and its field stores located in all active California oil fields, has been serving the oil industry for 20 years. This appointment will enable the oil industry to take advantage of Petroleum Equipment Co.'s broad engineering and service organization which is now equipped to offer direct factory delivery and service facilities on Dugas fire extinguishing equipment and apparatus.

Dugas Engineering Corp. was purchased outright two years ago by the Ansul Chemical Co. of Marinette, Wisconsin and is being operated as a wholly owned subsidiary. The Ansul Chemical Co. is one of the oldest and largest manufacturers of refrigerants in the country.

Coastal District

Royalty Service Abandons Santa Maria Area Wildcat

Royalty Service Corp. abandoned its Santa Maria Area wildcat, Careaga No. 1 at 5578 ft. after a formation test from 5278 to bottom at 5578 ft. recovered gassy mud and salt water with only traces of oil. Located in sec. 8,8n-33w near earlier exploratory holes, the Royalty Service project sought Miocene Chert Zone production similar to that in the neighboring Cat Canyon field.

Bell Corp. to Proceed With Lompoc Deep Test

Alphonzo E. Bell Corp. has received the green light from the Office of the Petroleum Coordinator at Washington and is proceeding with road grading operations preparatory to drilling Lompoc No. 6 as a deep test at the west end of the Lompoc field. The site chosen for the exploratory try adjoins old producing wells in sec. 28,8n-34w.

Standard Completing Cat Canyon Project

Standard Oil Co. is completing Los Flores No. 4 in the new Chert Zone area in sec. 27,9n-33w west of the north end of the old Cat Canyon field. A 7 in. combination string is landed on bottom at 6144 ft. and cemented through holes at 5757 ft., the top of the perforated interval. In the same section, Union Oil Co.'s Bell No. 13 is drilling below 5400 ft.

Alphonzo E. Bell Corp.'s Gilmore No. 1, located at the north end of the old shallow field in sec. 23,9n-33w, was deepened to 6377 ft. and is swabbing for a production test. Although the Chert at this location appears to contain oil, it does not give it up readily.

Ventura Wildcat Operations Told

Without undue interference from old man weather so far this winter, wildcat operations in Ventura county are proceeding according to schedule.

In the Bardsdale area, Ventura Southern Oil Co. resumed drilling early this month and is going ahead with McCampbell No. G-1 below 1250 ft. The well is located in sec. 19,3n-19w near the old shallow field. In sec. 6 of the same township, Palma Oil Corp. deepened its Elkins No. 1 to 3057 ft. and suspended operations. Bottom is reported in Sespe shale.

In the opinion of many observers, the Ojai-Santa Paula area will bear watching during the next few months. At the present time Richfield Oil Corp. is coring steeply dipping Miocene shale below 4030 ft. in Ojai No. 44 in sec. 13,4n-22w and Spencer D. Coates is drilling at a shallow level in Pirie No. 7. Several deals are said to be pending which will result in more work in this district.

In the Piru area, Delroy Petroleum Corp. is spudding a core hole in sec. 22,5n-18w and Pacific Western Oil Co. is preparing to drill Temescal No. 11.

Signal Petroleum Co. recently acquired the G. E. Development Co. properties totaling about 760 acres in Hopper Canyon. Seven old producing wells are included and the company plans a program of reconditioning and new development.

Two wells are active in the Sespe

COASTAL COUNTIES WILDCATS

Area	Well	No.	Section	Depth	Status
	Santa Barbara County				
Cat Canyon	Alphonzo E. Bell Corp., Gilmore	1	23, 9-33	6377	Swabbing
	O. C. Field & Wm. C. McDuffie et. al. Palmer-Stendel	13-1	13, 9-33		Rig
Careaga	Royalty Service Corp., Careaga	1	8, 8-33	5578	Abandoned
Casmalia	Dolly Adams Oil Co., Morganti	2	13, 9-35	1700	Testing
	O. C. Field Gas. Corp., Righetti	2	13, 9-35	2195	Pumps water
Lompoc	Alphonzo E. Bell Corp., Lompoc	6	28, 8-34		Grade
	Fickert Oil Co., Ltd., Well	1	8, 7-33		Rig
Santa Maria	John W. Lee, Trustee, T.G.	1	33, 10-33	3503	Idle
	Ventura County				
Bardsdale	Hopland Oil Co., Well	1	1, 3-19	4634	Idle
	Palma Oil Corp., Elkins	1	6, 3-19	3057	Idle
	Ventura Southern Oil Co.	G-1	19, 3-19	1250	Drilling
Conejo	Sycamore Oil Co., Boylan	1	23, 1-20	1700	Idle
Ojai	Coates, Spencer D. Pirie	5	7, 4-22	95	Drilling
	Kelalee Pet. Co., Harvey	1	8, 4-21		Rig
	Richfield Oil Corp., Ojai	44	13, 4-22	4030	Drilling
Piru	Delroy Pet. Corp., Fisk Core Hole	1	22, 5-18		Rigging up
	Pacific Western Oil Co., Temescal	11	4, 4-18		Rig
Sespe	Alford, J. A., Trustee, Goodenough	1	18, 4-19	2581	Re-rigging
	Ivers, H. A., Kentuck	13½	1, 4-20	1150	Drilling
Timber Canyon	Denison, A. T., Denison	1	13, 4-21	680	Drilling
	Crude Oils. Inc., West	1	19, 4-20	958	Idle
	Henderson-Ortez Oil Co., O'Leary	1	29, 4-20		Rig

NORTHERN COUNTIES WILDCATS

County	Well	No.	Section	Depth	Status
Colusa	Pacific National Pet. Corp.	1	17, 17n-4w		Spudding
Contra Costa	Faria, Joseph Jr., Faria	1	22, 2n-1w		Location
Madera	Blake, T. E., Chuck	1	28, 10s-17e		Rig
	Shell Oil Co., Inc., Chowchilla Farms	6-18	18, 10s-14e	2253	Drilling
Monterey	Loma Grande Oil Co., Corey	1	23, 24s-10e	3820	Redrilling
San Joaquin	Westates Pet. Corp., Spence	1	22, 1s-7e		Location
	Standard Oil Co., West Coast Life	2	4, 1n-5e		Grade
	Standard Oil Co., Blewett Comm.	3	23, 3s-6e		Rig
Sutter	Buttes Oilfields, Inc., Buttes	7	3, 15n-1e	5010	Drilling
	Buttes Oilfields, Inc., Buttes	8	28, 16n-2e	4150	Drilling
Yuba	Wright, L. G., Cox	1	18, 14n-5e	1805	Redrilling

Creek region; H. A. Ivers drilling at 1150 ft. in No. 13½ and Alford Drilling & Exploration Co. changing equipment to deepen Goodenough No. 1 to 2581 ft.

A. T. Dennison is reported drilling his No. 1 at Timber Canyon below 685 ft.

Petrol Completes Gato Ridge Well

The Petrol Corp. bottomed Magenheimer No. 661 in brown shale at 4209 ft. and completed on the pump for a few hours before shutting in for lack of pipeline connections. No gauges were taken but the yield was said to be satisfactory.

Republic Petroleum Co. has applied to the Petroleum Coordinator's office for permission to drill Price No. 1, derrick for which was built more than a year ago. The Price property is in sec. 16,8n-32w at the west flank of the fiield.

Macrate Completes Big Valley Producer

One of the largest wells in recent months was that obtained by A. N. Macrate & Sons in completing Fernandez No. 7 at Santa Maria Valley. With a 560 ft. interval open to bottom at 4320 ft., the well came in flowing at a rate estimated between 2500 and 3000 bbls. a day of clean oil. The well is located in sec. 26, 10n-34w in one of the most prolific sections of the field.

Union Oil Co. brought in Fleisher No. 3 in sec. 31-10n-33w in the southeasterly area pumping about 300 bbls. of gross fluid which runs 50-60 per cent water. The hole is open from 4155 to 4710 ft.

Signal Oil & Gas Co. completed Romalho No. 4 at 4928 ft. pumping at an estimated 500 bbl. rate.

Dolly Adams Tests New Casmalia Well

With the hole open in the old producing horizon from 1419 to 1700 ft., Dolly Adams Oil Co. is preparing to complete Morganti No. 2 in sec. 13,9n-35w at Casmalia. In the same section, O. C. Field Gasoline Co. continues testing below the established zones in Righetti No. 1 which was drilled to 2195 ft.

Lee Suspends At Santa Maria

Finding the oil in sands from 2240 to 3500 ft. too heavy to produce, John W. Lee, Trustee suspended operations for the time being in Title Guarantee No. 1 in sec. 33,10n-33w. The project is located approximately a mile southeast of production in the Santa Maria Valley field.

"Oil Well Drainage"

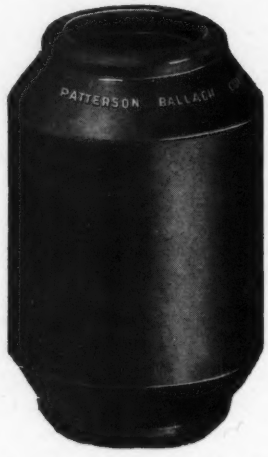
Here is a practical book written in easily readable style, expressly for geologists, engineers, landowners, leaseholders, and operators of producing oil and gas properties—those who meet directly the technological or financial issues of the industry. It is confined to the problem with which they are primarily concerned—drainage. The events and conditions within a producing reservoir are described, and the influences of well performance on the movement of the oil and gas is presented in simple terms. Analogies between artificial and natural reservoirs are considered, the nature of reservoir energy is discussed, and the function of gas in the production of oil is set forth. Included are the specific matters of drainage, such as radius and area, water encroachment, movement of oil and gas across property lines, effects of stratigraphy and structure, penetration, multiple zones, rates of production, and field development, as are also the questions of injection, reservoir content, ultimate recovery, reserves, abandoned oil and gas, curtailment, proration, and conservation. No other book completely covers this subject, and there are few writers as capable as Mr. Herold in presenting it in an understandable way to all concerned with field operations. This book contains the results of 12 years' experience in verifying the mathematical theory of well and reservoir performance previously presented in "Analytical Principles of the Production of Oil, Gas, and Water from Wells", by the same author, published in 1928. "Oil Well Drainage" is planned for maximum reference value. The chapters are divided into two parts, each one for two types of wells with distinct features in drainage. In the outer margin of the pages the subject content of the paragraphs is indicated, so that it is possible to locate in a minimum of time the particular information wanted.

The author, Stanley C. Herold, has been engaged in the exploration and exploitation of oil and gas fields during the last 25 years, having received his technical training in the geological, engineering, and scientific departments of Stanford University. From this institution he received an A.B. degree in 1909 and a Ph. D. degree in 1926. His experience has covered numerous fields in all parts of the United States and many foreign countries. He is now a consulting engineer and geologist with offices in Los Angeles.

"Oil Well Drainage", by Stanley C. Herold. Clothbound, 407 pages, illustrated. Published by Stanford University Press, Stanford University, Calif. Price $5.00.

Heavier Lips Added to Protectors

Following the introduction several months ago of lips to rubber protectors for drill pipe and casing, Patterson-Ballagh Corp. announces an improvement. The addition of lips to the ends of



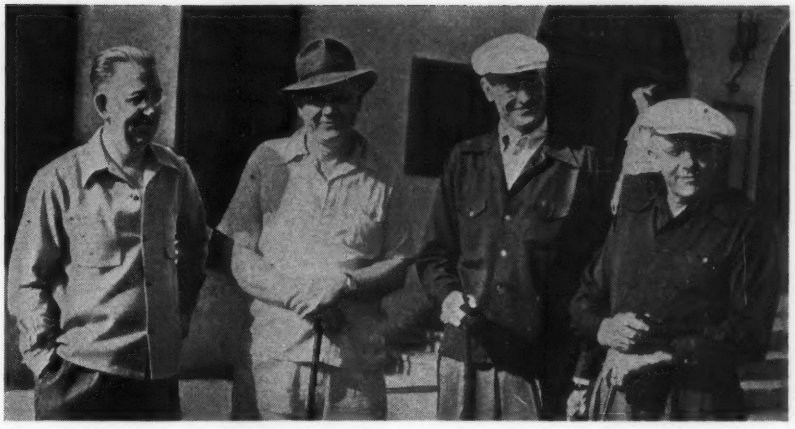
protectors has proved so successful that it was deemed advisable to increase the cross area of same. The newest type of protectors introduced recently by Patterson-Ballagh include heavier lips.

The cause of notch fatigue failure is the occurrence of a circumferential groove, or grooves, occurring on the pipe at the ends of protectors. This is not a prevalent condition, but in order to avoid any possibility of grooving, the lips were added. The occurrence of grooves is from corrosion, probably due to fluid being held at the corner while the pipe is standing in the derrick. Fatigue failures have been found which quite evidently started at the bottom of the grooves, as at the bottom of any transverse notch. Whether the ring is due to erosion or corrosion, the tendency of grooving is reduced by the use of protector lips, according to the manufacturers.

Nineteeners Hold Hundredth Meeting

Some thought it was an enemy bombing that did the damage. Others figured it might have been combat maneuvers by the Fourth Field Army. But if you want the plain unvarnished truth, all those trenches, pill boxes and escarpments blasting into the fairways of the beautiful Riviera Golf Course were just one afternoon's work for those indomitable oilmen —the NINETEENERS.

For on January 15th—a weekday afternoon when all self-respecting oil men were busy rounding out an honest day's toil—The NINETEENERS gathered in solemn conclave on the tricky Riviera course to celebrate the One Hundredth meeting of their organization. Started some eight years ago—September 16, 1933, to be exact—The NINETEENERS are a group of well-known oil men and supply men who have met regularly once a month for 100 months in Golf Tournament play. Twice yearly a club championship is won, and twice a year a parimutual event is held. The NINETEENERS also play for points on the Texas Trophy, a beautiful cup donated by two now-distant members, Ed Fisher and Doc Pennington, together with their friend "Poppy" Campbell.



K. T. Norris, Norris Stamping & Mfg. Co.; C. H. Tuttle, Standard Oil Co.; W. R. K. Scott, Jones Laughlin Steel Co., and Hans Ross, Baasch Ross Tool Co.

John Templeton, General Petroleum Corp.; Lev. Sacre, Allied Supply Co.; A. S. Hayes, Bell and Loffland Drilling Co., and Charlie Perkins, Union Oil Co.

Ward B. Blodget, Petroleum Engineer and Geologist; J. V. MacDonald, Chain Belt Co.; Gill Nesheim, Allied Supply Co., and Henry Paulson, Bankline Oil Co.

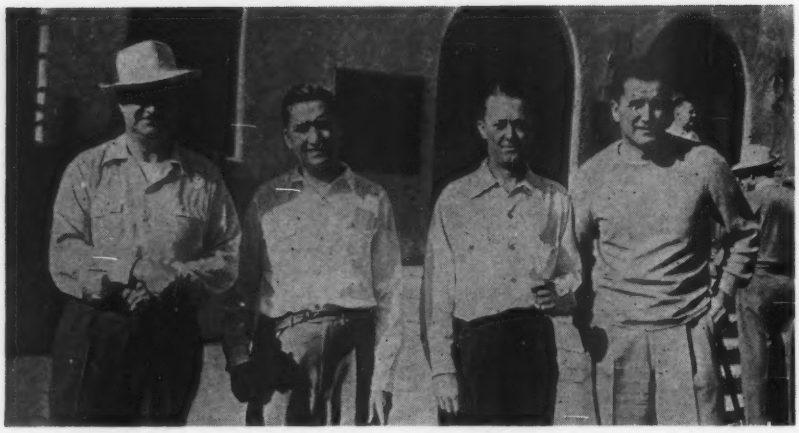
The One-Hundredth Meeting started with the usual fairway fanfare as the first foursome all hooked off the course into the Riviera stable grounds. The succeeding foursome had a little better luck, although it was nip and tuck all the way as to who was going to level off the most trees from the course. Olin Magary, "Hot Shot" (Vice President) of The NINETEENERS had managed to promote a blind bogey card among the unsuspecting members and after an afternoon of furious divot digging none other but Percy Hayes of Universal Consolidated came up with the blind bogey award, which was pretty much in order since "Twinkletoes" negotiated the course half blind anyway.

Fred Curry of Timken Steel emerged with the low net prize while second place was tied between Monte Lindmoe of Southwest Welding and "Doc" Emmons of The Texas Co., said tie to be played off at the next NINETEENERS encounter in February at the Wilshire Country Club.

Celebration Dinner

However, the real festivities began popping after the last foursome had struggled in. (The tail-end threesome failed to finish because Jerry O'Leary of Chapman Valve found the going too tough for his "too-little and too-late" type of golf, barely making the half-way mark before folding up like a punctured accordion.)

Naturally, the highlight of the meeting was the One Hundredth Celebration Dinner held in the clubhouse that evening. Some of the NINETEENERS, notably Dutch Zwerneman of Axelson, Lex McGurn of Union Oil, and Van Horn of Richfield couldn't break away for the golf but did manage to skid in under the wire in time for the excellent dinner which



E. W. Beck, General Petroleum; R. I. Whalen, Youngstown Steel Products Co.; R. L. Lohman, Lohman Bros., and Monte Lindmoe, Southwest Welding and Mfg. Co.

G. B. Tunnell, Allied Supply Co.; Holly Hayter, Tide Water Associated Oil Co.; Fred H. Currie, Timken Steel & Tube Co., and Joe E. Aderhold, Allied Supply Co.

Val Montgomery, Bennett Montgomery Hardware Co.; O. J. Magary, Petroleum Equipment Co.; P. J. Hayes, Universal Consolidated Oil Co. and Hal Lindquist, Vitachrome Co.

was enjoyed by all. That is, all except Dick "Seabiscuit" Townley of C. F. Braun who, as usual, couldn't finish his dinner because the cook had neglected to completely cremate the steak.

Special guests for the occasion included Val Montgomery of Bennett-Montgomery Hardware Co., W. R. K. Scott of Jones and Laughlin Steel, Henry Wurdenman of New York City, Allen Johnson of Pacific Wire Rope, Walter Monroe of California Oil World and Sam Eastman of Dozier-Graham-Eastman, Advertising Counselors. Van Horn of Richfield who was one of the first NINETEENERS but later had to retire from golf, was on hand nevertheless to join the group in its One Hundredth Celebration Meeting.

During the dinner, numerous congratulatory telegrams came in and were read by Jim MacDonald, "Big Shot" (President) of the organization. Hardly had he finished the last of these when a sudden burst of shell fire staccatoed across the room and everyone made a dive under the table. Cy Perkins of Union Oil Company proved to be the deepest diver, wiggling his way to the bottom of the heap before the rest could even get their knees bent. The alarm proved to be the work of his excellency Ken Norris, former "Big Shot" and now a pillar in the government defense program. It seems that Ken's Norris Stamping and Mfg. Co. was recently the recipient of the Navy's letter "E" for excellence in production, the honor flag now flying over his plant; so, by way of celebration Ken burst in rapid fire order the bulk of the balloons around the table, causing pandemonium plus. However, the long arm of the law caught up with Ken for he had to pay a $2.00 fine for using up rubber without a priority.

The current club champion, Doc Hayes of Bell & Loffland, was asked to arise so that the members might see what a real nibblick nudger looks like at the top of his game, while Percy Hayes, the EX club champ (now known as "The Worm") was called upon to show the members the low level to which a "has been" can sink. Incidentally, just how Hayes and Hayes (no relation) have managed to monopolize past and present championships is somewhat of a mystery, as they are both in a "haze" most of the time—and no pun intended.

Monte Lindmoe of Southwest Welding, the official "Caruso" of the crowd, busied himself rasping out a tune or two for the benefit of Hans Ross, after-half of the Baash-Ross organization, and not to be outdone, Tommy Bell of Jones & Laugh-31—OIL WORLD....mac .. .. lin, and Doc Emmons gave the Cornell alma mater song a working over, followed by Ward Blodget, independent operator, and Percy Hayes who sprang a leak on the Stanford alma mammy. With their college loyalties off their chests, and with their first full meal in months under their belts, The NINETEENERS were then able to get down to the business of the evening—fun and frolic.

Play Presented

A one-act play written especially for

(Continued on Page 32)

More Nineteeners

C. E. Emmons, Texas Co.; T. W. Bell, Jones Laughlin Steel Co.; A. C. Johnson, Pacific Wire Rope Co., and H. E. Chapman, Petroleum Equipment.

Right to left, for a change: Sam Eastman, Dozier, Graham, Eastman; Jerry O'Leary, Chapman Valve Mfg. Co., and Walter Monroe, California Oil World.

C. N. G. A. Hears Sabotage Talk

How to minimize chances for sabotage, and how to protect personnel and equipment during air raids, were subjects discussed by experts before a recent special meeting of the California Natural Gasoline Association at Long Beach. Before introducing the featured speaker, P. S. Magruder, who represents the natural gasoline and natural gas branches in the recently set up Petroleum Safety Division, recalled the Sunday when war was declared and blackouts were ordered:

"No one at that time knew just what to do. They were told to blackout. Well, everyone did his best to carry out those orders. We had no very serious accidents, but the possibilities were tremendous. I know that in our own plants we were operating without any lights except the flashlights carried by the men.

"The blackouts December 7 and 8 accomplished one thing, they showed the serious need for some central authority from whom recommendations and instructions would originate."

The principal speaker at this special meeting was Blayney F. Matthews, superintendent of safety and personnel at Warner Brothers. He was formerly one of the chief deputies in the office of the District Attorney, specializing in sabotage cases. Mr. Matthews indicated a number of approaches to coping with the problem of saboteurs. The first factor is the immediate neighborhood of the industrial plant. Questions that must be answered include: Who lives in the neighborhood? What type of buildings are there near the plant? Are there buildings from which incendiary bombs could be thrown? What do you know about the itinerant peddler, the news hawker, the old lady who sells flowers? What do you know about those apparently innocent passersby who may be observing, not alone the number of employes that go in or out, but their usual disposition about the plant?

Under the heading of "Examination of Personnel," Mr. Matthews said that after assuring that maximum protection has been provided for mechanical units, the personnel working in or near vital equipment must be checked. With a questionnaire it may be possible to ascertain not alone the individual's technical proficiency, but also his nationalistic background. The most important tools used by the master saboteur are blackmail, extortion and bribery. The safe workman must be established as a good citizen and must be known to associate only with good citizens, and that he has sufficient financial stability to preclude bribery.

No unauthorized visitor must be permitted to enter the industrial plant.

How will the saboteurs strike? Mr. Matthews pointed out various ways:

Arson, explosives, disease germs, and false rumors. So far as disorganizing and slowing down or stopping production entirely is concerned, the saboteur can work just as effectively by making a large group of employes ill as by plant-

ing a bomb. The man who spreads false rumors, who will go into a plant and say, "I heard on good authority there is an infernal machine planted in some part of this plant," can do as much toward disturbing the morale of the individuals in that plant as if he had planted a bomb. The employes become uneasy, then their families, and pressure is exerted to quit such a hazardous occupation.

Mr. Matthews said he did not consider the possibility of an air raid farfetched. He said that the Japanese are a fanatical race who feel that death in the interest of their Emperor is the greatest thing to hope for and that they will receive spiritual rewards afterwards.

Discussions which followed Mr. Matthew's talk indicated that rapid strides have been made in effectuating a program of cooperative activity which will greatly reduce danger resulting from sabotage or bomb hits.

Two New Bulletins Issued by Lane-Wells

Lane-Wells announces publication of two new bulletins.

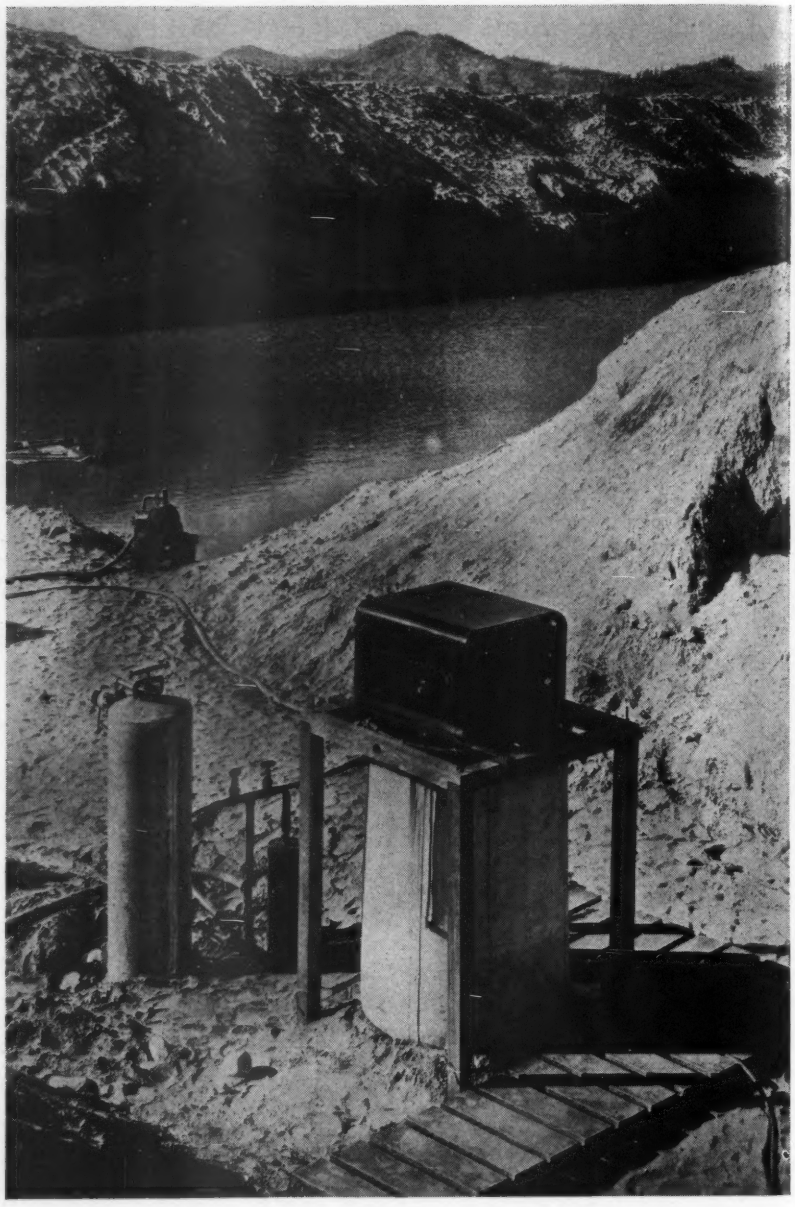
The Lane-Wells Electrolog Bulletin has been completely revised and brought up to date, and contains a discussion on new services Lane-Wells is now in a position to make available to the oil industry.

There is an interesting comparison of Electrolog and Radioactivity Log curves, showing the correlation of the two types of curve made in uncased and cased hole. An explanation is given of the temperature survey service, and pertinent data is given on the comparative weights of Electrolog cable in drilling mud.

The Quinta-Seal Packer and Liner Hanger Bulletin contains up-to-date engineering information on the use of these specialized tools.

The petroleum industry is facing a critical situation, and Lane-Wells feels that information about Packers and Liner Hangers will enable oil companies to meet the demands of 1942 production more efficiently.

Copies of the bulletins can be obtained without charge from any of the Lane-Wells branches, or from the general office at 5610 S. Soto St., Los Angeles.



Sterozone Model B Water Purification Unit set up with auxiliary supply unit and filter tanks. Drainage water from gravel pit is filtered and purified in 250 gallon batches. No chlorine or other chemicals are used. Treated water is pure, odorless, tasteless and colorless.

Portable Ozone Unit Purifies Water

A portable, automatic ozone water purification unit, designed for oil field use in all localities, has been developed by the Technicraft Engineering Co., a division of Lane-Wells Co., 5610 South Soto Street, Los Angeles, Calif. The unit, known as the Sterozone Model B, has a capacity in excess of 1200 gallons per hour. It can be installed in any tank or water storage container or can be equipped with a 250-gallon canvas bag. Power is supplied from a 110-volt, 50-60 cycle line or from an auxiliary portable gasoline-electric generator. Operation of the unit is entirely electrical. No Chlorine or other chemical is needed.

The sterilizing agent is ozone generated by a silent electrical discharge maintained at 11,000 volts. Injected directly into the water passing through the unit, the ozone completely oxidizes bacterial contamination and produces clear, pure, colorless, odorless, tasteless water.

Complete description, together with results of laboratory tests of water treated by the unit, is available from the manufacturer.

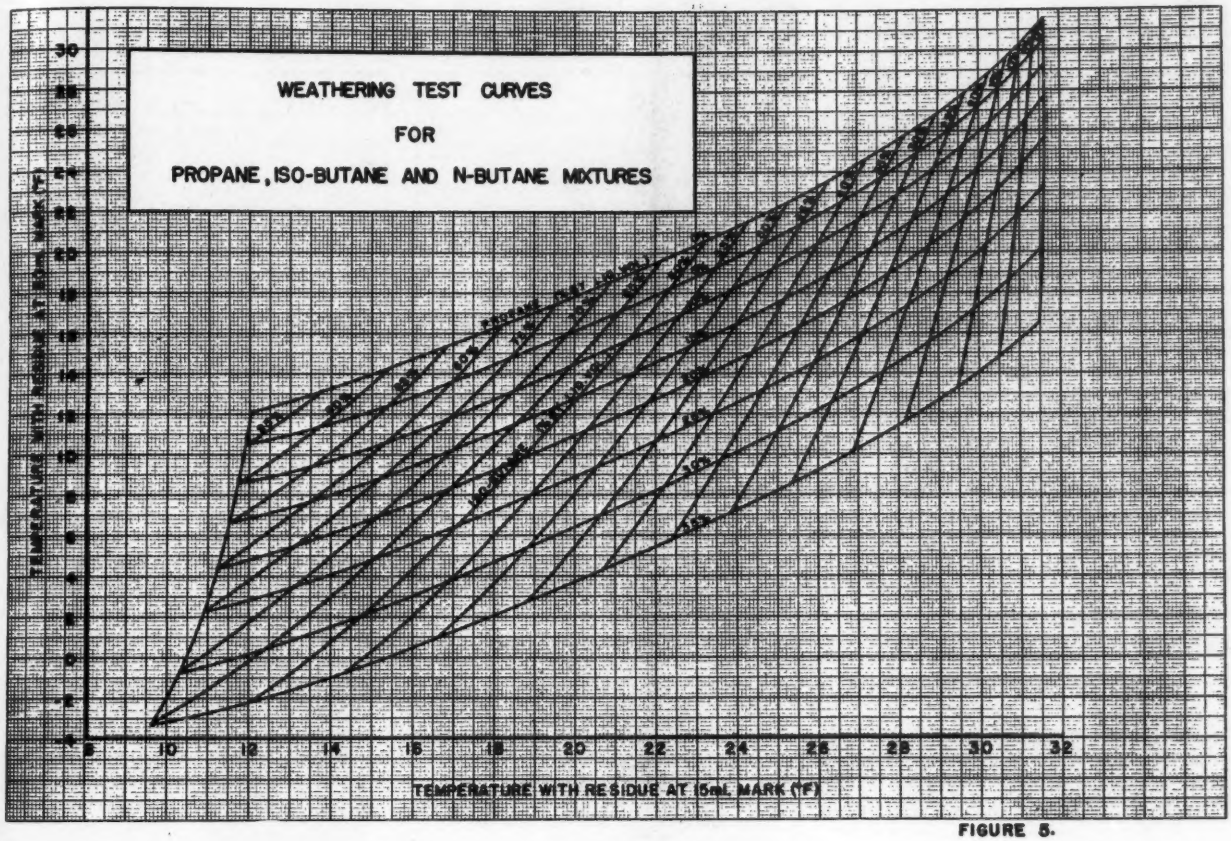


FIGURE 5.

Extension of Weathering Test Curves for Propane, Isobutane, N-Butane Mixtures

By W. M. Schaufelberger
Standard Oil Co. of California

At the March 6, 1941, meeting of the California Natural Gasoline Association, O. N. Miller, L. G. Horn and W. K. Venatta of the Standard Oil Co. of California presented a weathering test procedure for determining the composition of propane, isobutane, n-butane mixtures. This test involved weathering approximately a 100 ml. sample of liquid in a calibrated weathering tube, observing the boiling temperatures at the 50 ml. and 15 ml. residue points and interpretation of these results on a weathering test chart.

The range of application of this weathering test chart has been extended on the basis of additional test data to permit its application to a wider variety of products. Whereas the original chart applied to stocks containing a minimum of 35 per cent isobutane and a maximum of 25 per cent propane, the revised curve sheet extends the isobutane minimum to 0 percent and the propane maximum to 35 per cent.

The weathering test was originally developed to meet control problem needs in the refinery. The revised chart may be found useful in intercompany transfers of natural gasoline plant products.

Above paper was published in the Second Issue, March, 1941, California Oil World.

Rio Hondo Wildcat Fishing Drill Pipe

Potrero Oil Co.'s wildcat, Neuman No. 1, is reported to be circulating oil to loosen drill pipe stuck on bottom at 570 ft. Formation is believed to be Upper Repetto. The well is lcated a mile north of the east end of Montebello and just east of Rosemead Blvd.

Here and There

W. H. "Whitey" Eastham, Wilmington Division Superintendent for Royalty Service Corp., has an unusual collecting hobby. In his desk is a box containing nearly ninety automatic pencils bearing the name, address and telephone number of an oil field tool or service company, not one of which is duplicated in the collection. Show Whitey a pencil and he can tell at a glance if he owns one, and if he doesn't you should see the collector's gleam light up in his eyes. (Note to Wilmington peddlers—check over your pencil supply for odd or unusual types.)

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FOR SALE

Franks portable coring rig. Derrick, drawworks, mud pump, all equipment completely portable, mounted on Ford V-8 Truck. Equipment, tires excellent condition. Box No. 50, care California Oil World. 2/5d

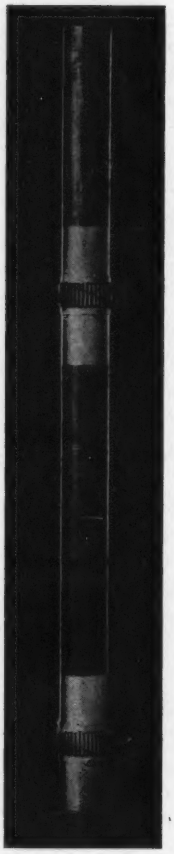
(Continued from Page 28)

the occasion, titled "GOLF HISTORY IN THE MAKING" was presented, starring such box office poison as Ward Blodget, Jay Perrin of Towelsaver, Lev Sacre of Allied Supply and Hal Davis of Richfield. Immediately following its first presentation, the play was retitled "TARGET FOR TONIGHT" and unanimously nominated for oblivion . . . along with the actors, who were donated with a box of tomatoes, one by one.

But the real dramatics of the evening took place when the members and guests settled down to as fine an exhibition of "Nothing Up My Sleeve (Except Five Aces)" as you'd care to find in these parts. The stakes became so wild during these festivities that at one time "Hole-in-Nine" Jorgensen, well-known steel man, recklessly tossed into the pool his 7 per cent interest in a white sidewall recap. The boys figured anyone risking high stakes like that must have at least a royal flush hidden away so didn't even ask for a show.

With their first hundred meetings under their belt, The NINETEENERS look forward to completing the next hundred in quick order, despite the coming shortage of golf balls. As Joe Aderhold of Allied Supply puts it, there's never a shortage of fun, good food and friends, and these are the real things that make The NINETEENERS click so successfully month after month.

New B and W, Inc., Device On Deepening and Workover



B and W, Inc., of Houston, Texas and Long Beach, California, makers of B and W Wall Cleaning Guides, have announced a new product called the B and W Guide - Mounted Liner Section, with the following field applications:

1. On deepening jobs below 5½" or 7" oil strings to correct high gas/oil ratios or water entrance.

2. On deepening jobs to develop lower productive sands.

3. On workovers where it is necessary to side-track out through a 5½" or 7" oil string.

It is desirable to use a liner with as large a diameter as possible on these workovers, and the reduced clearances make necessary the design shown in the cut. Well Cleaning Guides are mounted in the wall of the casing and it is possible to run 4" O.D. liner through 5½" oil string or 5½" liner through 7" oil string.

The liner sections are made up in 6' lengths of plain end pipe with two Wall Cleaning Guides mounted at 3' centers as shown. These sections may be threaded and coupled or inserted. Short liners may be made up entirely of a series of these sections. On longer liners, these liner sections may be installed at selected levels.